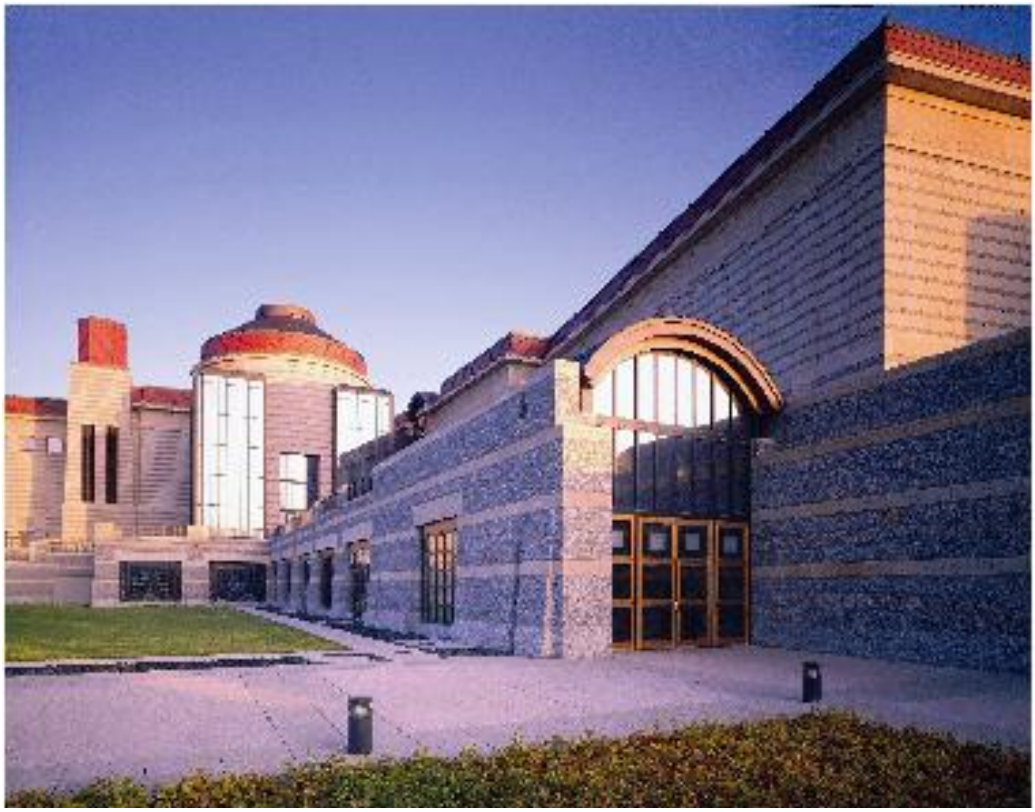
PBEEEP
State Government

Public Buildings Enhanced Energy Efficiency Program

Final Report
Investigation Results For
Minnesota History Center

Minnesota Historical Society

Date: 9/29/2011



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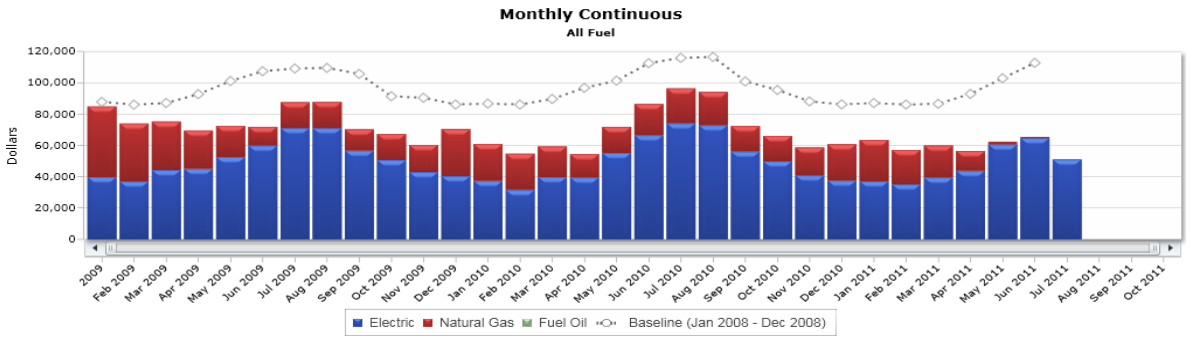
MN History Center Energy Investigation Overview

The goal of a PBEEEP Energy Investigation is to identify energy savings opportunities with a payback of fifteen years or less. Particular emphasis is on finding those opportunities that will generate savings with a relatively fast (1 to 5 years) and certain payback. During the investigation phase the provider conducts a rigorous analysis of the building operations. Through observation, targeted functional testing, and analysis of extensive trend and portable logger data, the RCx Provider identifies deficiencies in the operation of the mechanical equipment, lighting, envelope, and related controls. The investigation of the Minnesota History Center was performed by Ericksen, Ellison & Associates. This report is the result of that information.

Payback Information and Energy Savings				
Total Project costs (Without Co-funding)			**Project costs with Co-funding**	
Total costs to date including study	$111,656		Total Project Cost	$221,586
Future costs including Implementation , Measurement & Verification	$109,929		Study and Administrative Cost Paid with ARRA Funds	($111,656)
Total Project Cost	$221,586		Xcel Study rebate (to History Center)	($25,000)
			Total costs after co-funding	$84,929
Estimated Annual Total Savings ($)	$68,487		Estimated Annual Total Savings ($)	$68,487
Total Project Payback	3.2		Total Project Payback with co-funding	1.2
Electric Energy Savings	**8.7%**	**and**	**Gas Energy Savings**	**8.3%**



Year	Days	SF	Total kBtu	Normalized Baseline kBtu	Change from Baseline kBtu	% Change	Total Energy Cost $	Average Cost Rate $ /kBtu
2009	365	517,557	84,479,567	91,083,717	-6,604,150	-7%	$891,470.06	$0.01
2010	365	517,557	74,415,863	90,359,889	-15,944,026	-18%	$836,276.32	$0.01
2011	211	517,557	29,740,293	52,930,822	-23,190,529	-44%	$416,139.28	$0.01

State of MN History Center Consumption Report

Admin Minnesota
DEPARTMENT OF ADMINISTRATION

STATE OF MINNESOTA B3 BENCHMARKING

Energy use has dropped over 14% since the start of the Investigation

Summary Tables

Facility Name	History Center
Location	345 Kellogg Blvd W St. Paul, MN 55102
State ID#	E4002502501
Facility Manager	Gene Peterman
Number of Buildings	1
Interior Square Footage	492,097
Year Built	1992
PBEEEP Provider	Erickson, Ellison and Associates
State's Project Manager	Larry Nichols
Date Visited	April 5, 2010
Annual Energy Cost	$893,695 (2009)
PBEEEP Engineer	Neal Ray
Utility Company	Xcel Energy: Electric and Natural Gas
Site Energy Use Index (EUI)	159 kBtu/ft^2 (2010) 127 kBtu/ft^2 (at end of study)
Benchmark EUI (from B3)	176 KBtu/ft^2

Mechanical Equipment Summary Table	
Quantity	**Equipment Description**
1	Honeywell EBI Automation System
31	Air Handlers
247	VAV Boxes
4	Chillers
2	Cooling Towers with Fans
4	Chilled Water Pumps
12	Hot Water Pumps
27	Exhaust fans
6	FCUs
1,000	Approximate number of points for trending

Implementation Information			
Estimated Annual Total Savings ($)			$68,487
Total Estimated Implementation Cost ($)			$109,929
GHG Avoided in U.S Tons (CO2e)			1,013
Electric Energy Savings (kWh)	8.7% Savings		903,389
Electric Demand Savings (Peak kW)	0.5% Savings		9
Natural Gas Savings (Therms)	8.3% Savings		43,182
Statistics			
Number of Measures identified			11
Number of Measures with payback < 3 years			7
Screening Start Date	03/11/2010	Screening End Date	04/27/2010
Investigation Start Date	08/06/2010	Investigation End Date	07/25/2011
Final Report	09/29/2011		

MN History Center Cost Information			
Phase		**To date**	**Estimated**
Screening		$4,563	
Investigation [Provider]		$95,200	
Investigation [CEE]		$11,893	
Implementation			$105,929
Implementation [CEE]			$2,000
Measurement & Verification		0	$2,000
Total		$111,656	$109,929

Co-funding Summary	
Study and Administrative Cost	$111,656
Utility Co-Funding - Estimated Total ($)	$25,000
Total Co-funding ($)	$136,656

Building Overview

The building runs on a Honeywell EBI automation system. All equipment is on the automation system except several CUH and UHs, which are controlled by manual thermostats on the wall. The building was constructed in 1992. There was a recent HVAC upgrade to the sequences and automation system. The building was also tested and balanced at this time. The building has never had any projects commissioned or retrocommissioned.

The building contains a total of four chillers, one of which was out of service (it was put back in service in 2011). Two are used to supply chilled water to cooling coils in all the AHUs for cooling. The third chiller supplies chilled water to units serving artifacts areas, this chiller needs to produce chilled water at a lower temperature then the two other chillers in order to meet strict temperature and humidity requirements in the space. These chillers are connected to two large cooling towers.

There are four gas fired boilers, which use fuel oil as a backup fuel source. Three boilers are used to supply hot water to AHUs hot water coils and VAV reheat coils. These three boilers are identical and each is rated at 6,695 kBtu/hr and delivers hot water at around 180 ºF. The other boiler is used to generate steam for humidity and is rated at 5,021 kBtu/hr.

There are a total of 31 AHUs serving all the spaces within the History Center: Ten of the AHUs are constant volume, nine are multi-zone units, four are dual duct, and eight are variable air volume units with VAV boxes.

The space uses vary significantly throughout the building. The building includes museum space and storage of artifacts which require specific temperature and humidity conditions at all times. There are a total of six floors. The first two floors, floors (A and B) are mostly office, research and storage space. The next floor (Level 1) consists of a large café which serves food to the public and employees and an auditorium, and gift shop, The upper three floors (Levels 2, 3 and 4) consist of galleries which have artifacts and displays for the public to view, classrooms, office space and two libraries . There are three large open atriums that run from levels 1 through 4 in the building as well. These open areas not only contain other displays for the public to view, but are also rented out for private parties and formal events such as weddings.

There are two gas meters, one interruptible and one firm; and one electrical meter.

Findings Summary

Site: MN History Center

Building: Minnesota History Center

Eco #	Investigation Finding	Total Cost	Savings	Payback	Co-Funding	Payback Co-Funding	GHG
6	Time of day enabling is excessive	$1,600	$45,063	0.04	$0	0.04	686
7	Equipment does not operate with an unoccupied setback	$1,600	$3,438	0.47	$0	0.47	51
9	Facility does not utilize low flow lavatories for public restrooms. Thus they use more hot water tha	$744	$722	1.03	$0	1.03	7
1	Kitchen exhaust/supply systems scheduling	$5,890	$5,107	1.15	$0	1.15	78
18	Unsealed holes in air handler supply ductwork	$50	$28	1.81	$0	1.81	0
11	Over Ventilation	$600	$275	2.18	$0	2.18	1
8	Equipment does not operate with an economizer cycle or the existing economizer cycle is disabled	$3,160	$1,323	2.39	$0	2.39	16
4	ASD fan control	$69,900	$10,758	6.50	$0	6.50	154
20	No hot water supply temperature reset active on boilers	$2,270	$339	6.70	$0	6.70	4
10	Simultaneous Heating & Cooling	$5,910	$469	12.61	$0	12.61	6
2	Outside air volume control	$14,205	$965	14.72	$0	14.72	10
	Total for Findings with Payback 3 years or less:	**$13,644**	**$55,956**	**0.24**	**$0**	**0.24**	**840**
	Total for all Findings:	**$105,929**	**$68,487**	**1.55**	**$0**	**1.55**	**1,013**

PBEEEP was made possible with funding from the U.S. Department of Energy and the MN Department of Commerce.

Findings Details

Site: MN History Center

FWB Number:	10800	Eco Number:	1
Building:	Minnesota History Center	Date/Time Created:	9/26/2011

Investigation Finding:	Kitchen exhaust/supply systems scheduling	Date Identified:	9/23/2010
Description of Finding:	Kitchen cookline exhaust hood and air handler are running when the kitchen is not in service. This system also serves the cafÃ© area which is occupied when the kitchen is not, but the system can adjust the OSA requirements when the the kitchen exhaust fans are off. The existing schedule for this air handler (AHU-16) does not match the current occupied/unoccupied usage in the building.		
Equipment or System(s):	AHU with heating and cooling	Finding Category:	Equipment Scheduling and Enabling
Finding Type:	Equipment is enabled regardless of need, or such enabling is excessive		

Implementer:	Contractor	Benefits:	Heat sensor will activate kitched exhaust hoods only when the equipment beneath them is being used and will shut down automatically.
Baseline Documentation Method:	The existing equipment schedules for the affected equipment (AHU-16, E-2, E-3, E-4) were collected from the BMS system (Current Equipment Schedules.pdf) and verified with trending of the Supply Fan(s), and Return Fan(s) (AHU-16f.xls, AHU-16s.xls, AHU-16w.xls). A discussion with the Owner led to the creation of a new proposed schedule that more closely matches the current occupied schedule (Proposed Schedule Changes.xls).		
Measure:	Installation of heat sensor in exhaust duct collar of kitchen hood and modify air handler operating schedule.		
Recommendation for Implementation:	Contractor shall install 1 heat sensor in each exhaust duct collar for the kitchen hoods. This heat sensor shall automatically enable the associated exhaust fan(s) whenever the cooking equipment is active and disable the exhaust fan(s) when cooking equipment is off. Contractor shall modify the air handler (AHU-16) occupied/unoccupied schedule in BMS system to match current space usage schedules.		
Evidence of Implementation Method:	Verification of Implementation shall require: The following trend logs of the kitchen air handler and exhaust fan (AHU-16, E-2, E-3, E-4) shall be taken on 15 minute intervals for 2 week(s): Supply fan(s) speed, Return fan(s) speed, Exhaust fan(s) status, Air handler Occupied/Unoccupied status. These trend logs can be compared to information from facility on kitchen operating hours during the same time period. This will show that the exhaust fans are not running when the kitchen is not used and that the air handler schedule has been modified correctly.		

Annual Electric Savings (kWh):	77,014	Annual Natural Gas Savings (therms):	2,156
Estimated Annual kWh Savings ($):	$3,950	Estimated Annual Natural Gas Savings ($):	$1,157
Contractor Cost ($):	2,240		
PBEEEP Provider Cost for Implementation Assistance ($):	3,650		
Total Estimated Implementation Cost ($):	$5,890		

Estimated Annual Total Savings ($):	$5,107	Utility Co-Funding for kWh ($):	$0
Initial Simple Payback (years):	1.15	Utility Co-Funding for kW ($):	$0
Simple Payback w/ Utility Co-Funding (years):	1.15	Utility Co-Funding for therms ($):	$0
GHG Avoided in U.S. Tons (C02e):	78	Utility Co-Funding - Estimated Total ($):	$0

Current Project as Percentage of Total project			
Percent Savings (Costs basis)	7.5%	Percent of Implementation Costs:	5.6%

PBEEEP was made possible with funding from the U.S. Department of Energy and the MN Department of Commerce.

Findings Details

PBEEEP State Government

Site: MN History Center

FWB Number:	10800	Eco Number:	2
Building:	Minnesota History Center	Date/Time Created:	9/26/2011

Investigation Finding:	Outside air volume control	Date Identified:	9/23/2010
Description of Finding:	Multiple pieces of equpment do not use CO2 levels to modulate outside air volume in spaces where occupancy levels change significantly. The equipment affected is: AHU-19, AHU-20, AHU-21		
Equipment or System(s):	AHU with heating and cooling	Finding Category:	Economizer/Outside Air Loads
Finding Type:	Other Economizer/OA Loads		

Implementer:	Contractor	Benefits:	The affected air handlers will only bring in the minimum required volume of outside air to serve the current occupancy level of the space.
Baseline Documentation Method:	The following items were trended during the fall for the affected equipment (AHU-19, AHU-20, AHU-21): OSA Damper Position, Min OSA Damper Position, Return Air Damper Position, Mixed Air Temp, Return Air Temp, and OSA Temp. The OSA % was calculated by first verifying that the OSA temperature was below 45Â°F to ensure the unit is not economizing. The OSA % was calculated with the following formula OSA% = (Mixed Air Temp â€“ Return Air Temp)/(OSA Temp â€“ Return Air Temp). These values were then averaged over the entire trending period (AHU-19f.xls, AHU-20f.xls, AHU-21f.xls). This calculated value was compared to the ASHRAE 62.1 required OSA flow (ASHRAE OSA Calcs.xls). The spaces served by this equipment are primarily education (class rooms) and office space. These spaces see dramatic shifts in occupancy throughout the day as classes start and stop. Therefore this equipment was determined to be a good candidate for adding CO2 sensors for OSA volume control.		
Measure:	Install CO2 sensors in the individual classroom return air ducts and add BMS programming to utilize CO2 for control of outside air dampers.		
Recommendation for Implementation:	For the affected air handlers (AHU-19, AHU-20, AHU-21), the contractor shall install 1 CO2 sensor in the return air stream or space for each critical space VAV box (AHU-19: 4002, 4003, 4007, 4008, 4009, 4011 AHU-20: 4015, 4017, 4025) and 1 CO2 sensor in the return air stream of AHU-21. The BMS system shall be modified such that the outside air flow rate shall modulate to maintain a maximum CO2 concentration level in any space of 1,000 PPM. The changes to the BMS system regarding OSA control will be coordinated with other controls that modulate the OSA dampers (Economizer modes, space pressure control, etc).		
Evidence of Implementation Method:	Verification of Implementation shall require: The following trend logs of each of the affected air handlers (AHU-19, AHU-20, AHU-21) shall be taken on 15 minute intervals for 2 week(s) to verify that the OSA volume modulates acceptably: Supply fan(s) speed, Return fan(s) speed, Air handler Occupied/Unoccupied status, Space CO2 sensor(s), Supply air flow, Return air flow, OSA damper position, Mixed air temperature, Return air temperature, and Outside air temperature. These trends will show that the OSA volume modulates such that the space CO2 level never exceed 1000 ppm.		

Annual Electric Savings (kWh):	751	Peak Demand Savings (kWh):	1
Estimated Annual kWh Savings ($):	$55	Estimated Annual Demand Savings ($):	$35
Annual Natural Gas Savings (therms):	1,629	Contractor Cost ($):	10,555
Estimated Annual Natural Gas Savings ($):	$875	PBEEEP Provider Cost for Implementation Assistance ($):	3,650
		Total Estimated Implementation Cost ($):	$14,205

Estimated Annual Total Savings ($):	$965	Utility Co-Funding for kWh ($):	$0
Initial Simple Payback (years):	14.72	Utility Co-Funding for kW ($):	$0
Simple Payback w/ Utility Co-Funding (years):	14.72	Utility Co-Funding for therms ($):	$0
GHG Avoided in U.S. Tons (C02e):	10	Utility Co-Funding - Estimated Total ($):	$0

Current Project as Percentage of Total project			
Percent Savings (Costs basis)	1.4%	Percent of Implementation Costs:	13.4%

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Findings Details

PBEEEP State Government

Site: MN History Center

FWB Number:	10800	Eco Number:	4
Building:	Minnesota History Center	Date/Time Created:	9/26/2011

Investigation Finding:	ASD fan control	Date Identified:	9/23/2010
Description of Finding:	Currently single zone constant volume air handlers do not utalize VFDs on fan motor(s) to control fan speed to allow the unit to vary the fan speed and the zone heating/cooling demand varies. The equipment affected is AHU-3, AHU-8, AHU-11, AHU-12, AHU-17, AHU-18, AHU-26, AHU-30, AHU-31		
Equipment or System(s):	AHU with heating and cooling	Finding Category:	Variable Frequency Drives (VFD)
Finding Type:	VFD Retrofit - Fans		

Implementer:	Contractor	Benefits:	The fans in the affected air handlers will vary their speed as the heating/cooling load in the single space varies. This will save fan energy.
Baseline Documentation Method:	BMS screen shots and site verification of the affected equipment (AHU-3, AHU-8, AHU-11, AHU-12, AHU-17, AHU-18, AHU-26, AHU-30, AHU-31) showed that none of the equipment currently has a VFD controlled fan. The spaces served by the affected equipment are large single zone rooms with no/few internal partitions. Adding a VFD to this equipment would allow the units to provide only the minimum heating/cooling required to meet the space loads.		
Measure:	Install VFD, shaft grounding kits, and duct pressure sensros on affected air handlers and modify BMS programing.		
Recommendation for Implementation:	Contractor shall install 1 VFD and shaft grounding device on each fan motor. The Contractor shall field verify and install if necessary 2 duct mounted pressure sensors in the discharge ductwork to provide a high-limit supply are pressure safety setpoint of 3.0 INWC. The contractor shall modify the BMS programing such that the fan(s) in each system shall modulate based on space temperature while maintaining a slight positive pressure in the space. The contractor shall also modify the BMS programing such that the OSA dampers modulate open/closed as the fan(s) slow down/speed up to ensure adequate OSA is provided for ventilation.		
Evidence of Implementation Method:	Verification of Implementation shall require: The following trend logs of each of the affected air handlers (AHU-3, AHU-8, AHU-11, AHU-12, AHU-17, AHU-18, AHU-26, AHU-30, AHU-31) shall be taken on 15 minute intervals for three periods of 1 week(s) to verify that the fan(s) modulate acceptably while maintaining space temperature. This should be done in the summer (OSA temp> 85ÂºF), swing season (OSA temp ~ 45ÂºF), and in the winter (OSA temp <10ÂºF): Supply fan(s) speed, Return fan(s) speed, Space Temperature, OSA Temperature.		

Annual Electric Savings (kWh):	179,389	Contractor Cost ($):	66,680
Estimated Annual kWh Savings ($):	$10,758	PBEEEP Provider Cost for Implementation Assistance ($):	3,220
		Total Estimated Implementation Cost ($):	$69,900

Estimated Annual Total Savings ($):	$10,758	Utility Co-Funding for kWh ($):	$0
Initial Simple Payback (years):	6.50	Utility Co-Funding for kW ($):	$0
Simple Payback w/ Utility Co-Funding (years):	6.50	Utility Co-Funding for therms ($):	$0
GHG Avoided in U.S. Tons (C02e):	154	Utility Co-Funding - Estimated Total ($):	$0

Current Project as Percentage of Total project			
Percent Savings (Costs basis)	15.7%	Percent of Implementation Costs:	66.0%

PBEEEP was made possible with funding from the U.S. Department of Energy and the MN Department of Commerce.

Findings Details

PBEEEP State Government

Site: MN History Center

FWB Number:	10800	Eco Number:	6
Building:	Minnesota History Center	Date/Time Created:	9/26/2011

Investigation Finding:	Time of day enabling is excessive	Date Identified:	11/1/2010
Description of Finding:	Multiple pieces of equipment operate on an occupied/unoccupied schedule that is excessive and does not represent actual occupied hours. The equipment affected is: AHU-8, AHU-17, AHU-18, AHU-29, AHU-10, AHU-11, AHU-19, AHU-20, AHU-21, AHU-26, AHU-27, AHU-30, E-1, E-5, E-6, E-15, E-17, E-25, E-26		
Equipment or System(s):	Other	Finding Category:	Equipment Scheduling and Enabling
Finding Type:	Time of Day enabling is excessive		

Implementer:	Contractor
Benefits:	Energy will be saved through reduction in run time.
Baseline Documentation Method:	The existing equipment schedules for the affected equipment (AHU-8, AHU-17, AHU-18, AHU-29, AHU-10, AHU-11, AHU-19, AHU-20, AHU-21, AHU-26, AHU-27, AHU-30, E-1, E-5, E-6, E-15, E-17, E-25, E-26) were collected from the BMS system (Current Equipment Schedules.pdf) and verified with trending of the Supply Fan(s), and Return Fan(s) (AHU-8s.xls, AHU-17s.xls, AHU-18s.xls, AHU-29s.xls, AHU-10s.xls, AHU-11s.xls, AHU-19s.xls, AHU-20s.xls, AHU-21s.xls, AHU-26s.xls, AHU-27s.xls, AHU-30s.xls). A discussion with the Owner led to the creation of a new proposed schedule that more closely matches the current occupied schedule (Proposed Schedule Changes.xls).
Measure:	Update occupied/unoccupied schedules for equipment.
Recommendation for Implementation:	The contractor shall modify the existing Occupied/Unoccupied scheduleing in the BMS as indicated in Proposed Schedule Changes documents such that each unit is only in occipied mode when the space it serves is occupied.
Evidence of Implementation Method:	Verification of Implementation shall require: The following trend logs of each of the affected air handlers (AHU-8, AHU-17, AHU-18, AHU-29, AHU-10, AHU-11, AHU-19, AHU-20, AHU-21, AHU-26, AHU-27, AHU-30, E-1, E-5, E-6, E-15, E-17, E-25, E-26) shall be taken on 15 minute intervals for 2 week(s) to verify that the units are only in occupied mode when the program requires it: Air handler Occupied/Unoccupied status, Supply fan(s) speed/status, Return fan(s) speed/status, Space temperature(s) (100% of spaces), Space temperature(s) set-point(s) (100% of spaces).

Annual Electric Savings (kWh):	579,585	Annual Natural Gas Savings (therms):	34,204
Estimated Annual kWh Savings ($):	$26,702	Estimated Annual Natural Gas Savings ($):	$18,361
Contractor Cost ($):	1,600		
PBEEEP Provider Cost for Implementation Assistance ($):	0		
Total Estimated Implementation Cost ($):	$1,600		

Estimated Annual Total Savings ($):	$45,063	Utility Co-Funding for kWh ($):	$0
Initial Simple Payback (years):	0.04	Utility Co-Funding for kW ($):	$0
Simple Payback w/ Utility Co-Funding (years):	0.04	Utility Co-Funding for therms ($):	$0
GHG Avoided in U.S. Tons (C02e):	686	Utility Co-Funding - Estimated Total ($):	$0

Current Project as Percentage of Total project			
Percent Savings (Costs basis)	65.8%	Percent of Implementation Costs:	1.5%

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Findings Details

Site: MN History Center

FWB Number:	10800	Eco Number:	7
Building:	Minnesota History Center	Date/Time Created:	9/26/2011

Investigation Finding:	Equipment does not operate with an unoccupied setback	Date Identified:	11/1/2010
Description of Finding:	Multiple pieces of equipment operate 24 hours a day 7 days a week without an unoccupied setback. The equipment affected is: AHU-10, AHU-11, AHU-19, AHU-20, AHU-21, AHU-26, AHU-27, AHU-30		
Equipment or System(s):	Other	Finding Category:	Controls (Setpoint Changes)
Finding Type:	Zone setpoint setup/setback are not implemented or are sub-optimal		

Implementer:	Contractor	Benefits:	Energy will be saved through reduction in run time.
Baseline Documentation Method:	The existing equipment schedules for the affected equipment (AHU-10, AHU-11, AHU-19, AHU-20, AHU-21, AHU-26, AHU-27, AHU-30) were collected from the BMS system (Current Equipment Schedules.pdf) and verified with the existing sequence of operations and trending of the Supply Fan(s), OSA Damper(s), and Space Temp(s). A discussion with the Owner led to the creation of a new proposed schedule and unoccupied setback that more closely matches the current occupied schedule (Proposed Schedule Changes.xls).		
Measure:	Create occupied/unoccupied schedules for equipment.		
Recommendation for Implementation:	The contractor shall create Occupied/Unoccupied scheduleing in the BMS as indicated in Proposed Schedule Changes documents such that each unit is only in occipied mode when the space it serves is occupied.		
Evidence of Implementation Method:	Verification of Implementation shall require: The following trend logs of each of the affected air handlers (AHU-10, AHU-11, AHU-19, AHU-20, AHU-21, AHU-26, AHU-27, AHU-30) shall be taken on 15 minute intervals for 2 week(s) to verify that the unoccupied setback has been properly enabled: Air handler Occupied/Unoccupied status, Supply fan(s) speed/status, Return fan(s) speed/status, Space temperature(s) (100% of spaces), Space temperature(s) set-point(s) (100% of spaces).		

Annual Electric Savings (kWh):	40,593	Annual Natural Gas Savings (therms):	3,001
Estimated Annual kWh Savings ($):	$1,827	Estimated Annual Natural Gas Savings ($):	$1,611
Contractor Cost ($):	1,600		
PBEEEP Provider Cost for Implementation Assistance ($):	0		
Total Estimated Implementation Cost ($):	$1,600		

Estimated Annual Total Savings ($):	$3,438	Utility Co-Funding for kWh ($):	$0
Initial Simple Payback (years):	0.47	Utility Co-Funding for kW ($):	$0
Simple Payback w/ Utility Co-Funding (years):	0.47	Utility Co-Funding for therms ($):	$0
GHG Avoided in U.S. Tons (C02e):	51	Utility Co-Funding - Estimated Total ($):	$0

Current Project as Percentage of Total project			
Percent Savings (Costs basis)	5.0%	Percent of Implementation Costs:	1.5%

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Findings Details

PBEEEP State Government

Site: MN History Center

FWB Number:	10800	Eco Number:	8
Building:	Minnesota History Center	Date/Time Created:	9/26/2011

Investigation Finding:	Equipment does not operate with an economizer cycle or the existing economizer cycle is disabled	Date Identified:	11/9/2010
Description of Finding:	Multiple pieces of equipment do not utilize an economizer cycle or is programmed with economizer cycle that is disabled. The equipment affected is: AHU-19, AHU-20, AHU-21		
Equipment or System(s):	AHU with heating and cooling	Finding Category:	Economizer/Outside Air Loads
Finding Type:	Economizer Operation - Inadequate Free Cooling (Damper failed in minimum or closed position, economizer setpoints not optimized)		

Implementer:	Contractor	Benefits:	Energy will be saved through reduction in mechanical cooling requirements.
Baseline Documentation Method:	The existing sequence of operations for the affected equipment (AHU-19, AHU-20, AHU-21) were collected from the BMS system and verified with trending of the OSA Damper(s), Supply Fan(s), Return Damper(s), and OSA Temp (AHU-19f.xls, AHU-20f.xls, AHU-21f.xls) during the fall to determine that the affect equipment does not use an economizer when outside conditions would merit it.		
Measure:	Create/ re-enable economizer cycle for equipment.		
Recommendation for Implementation:	The contractor shall create/modify an economizer sequence for the affected air handlers (AHU-19, AHU-20, AHU-21) similar to existing economizer sequences currently in use at the facility. In cooling mode, when the outside air temperature is below 72Â°F, the unit shall modulate the outside air and exhaust air dampers open and return air dampers closed to maintain a mixed air temperature requiring little or no additional mechanical cooling. During none economizer conditions, the outside air dampers shall be controlled to meet the ventilation requirements for the space.		
Evidence of Implementation Method:	Verification of Implementation shall require: The following trend logs of each of the affected air handlers (AHU-19, AHU-20, AHU-21) shall be taken on 15 minute intervals for 2 week(s) to verify that the air handlers are properly economizing when the outside conditions merit it: Air handler Occupied/Unoccupied status, Air handler economizer status, Relief air damper(s) position, OSA air damper(s) position, Return air damper(s) position, Return air temperature, Return air humidity, Mixed air temperature, OSA temperature, OSA humidity.		

Annual Electric Savings (kWh):	19,141	Contractor Cost ($):	900
Estimated Annual kWh Savings ($):	$1,323	PBEEEP Provider Cost for Implementation Assistance ($):	2,260
		Total Estimated Implementation Cost ($):	$3,160

Estimated Annual Total Savings ($):	$1,323	Utility Co-Funding for kWh ($):	$0
Initial Simple Payback (years):	2.39	Utility Co-Funding for kW ($):	$0
Simple Payback w/ Utility Co-Funding (years):	2.39	Utility Co-Funding for therms ($):	$0
GHG Avoided in U.S. Tons (C02e):	16	Utility Co-Funding - Estimated Total ($):	$0

Current Project as Percentage of Total project			
Percent Savings (Costs basis)	1.9%	Percent of Implementation Costs:	3.0%

PBEEEP was made possible with funding from the U.S. Department of Energy and the MN Department of Commerce.

Findings Details

Site: MN History Center

FWB Number:	10800	Eco Number:	9
Building:	Minnesota History Center	Date/Time Created:	9/26/2011

Investigation Finding:	Facility does not utilize low flow lavatories for public restrooms. Thus they use more hot water tha	Date Identified:	9/23/2010
Description of Finding:	Facility does not utilize low flow lavatories for public restrooms. Thus they use more hot water than necessary.		
Equipment or System(s):	Other	Finding Category:	OTHER
Finding Type:	Other		

Implementer:	Contractor	Benefits:	Reducing the flow rates in the public lavatories will reduce the hot water usage at the building. This will save energy by reducing the amount of water that needs to be heated.
Baseline Documentation Method:	The flow of the existing lavatory faucets was measured to determine existing flow rates. This was combined with calculated usage information to determine the existing hot water usage.		
Measure:	Replace aerators in public lavatories with 0.5 GPM flow aerators.		
Recommendation for Implementation:	The contractor shall replace the flow control aerator in each public lavatory with an aerator that allows a maximum flow of 0.5 GPM		
Evidence of Implementation Method:	Verification of Implementation shall require: Visual inspection of the affected lavatories to verify that the aerators have been changed to low flow versions.		

Annual Natural Gas Savings (therms):	1,346	Contractor Cost ($):	744
Estimated Annual Natural Gas Savings ($):	$722	PBEEEP Provider Cost for Implementation Assistance ($):	0
		Total Estimated Implementation Cost ($):	$744

Estimated Annual Total Savings ($):	$722	Utility Co-Funding for kWh ($):	$0
Initial Simple Payback (years):	1.03	Utility Co-Funding for kW ($):	$0
Simple Payback w/ Utility Co-Funding (years):	1.03	Utility Co-Funding for therms ($):	$0
GHG Avoided in U.S. Tons (C02e):	7	Utility Co-Funding - Estimated Total ($):	$0

Current Project as Percentage of Total project			
Percent Savings (Costs basis)	1.1%	Percent of Implementation Costs:	0.7%

PBEEEP was made possible with funding from the U.S. Department of Energy and the MN Department of Commerce.

Findings Details

PBEEEP State Government

Site: MN History Center

FWB Number:	10800	Eco Number:	10
Building:	Minnesota History Center	Date/Time Created:	9/26/2011

Investigation Finding:	Simultaneous Heating & Cooling	Date Identified:	11/10/2010
Description of Finding:	Multiple pieces of equipment have some amount of simultaneous heating and cooling. The equipment affected is: AHU-6, AHU-8, AHU-9, AHU-16, AHU-26, AHU-28, AHU-29, AHU-30		
Equipment or System(s):	AHU with heating and cooling	Finding Category:	Controls Problems
Finding Type:	Simultaneous Heating and Cooling is present and excessive		

Implementer:	Contractor	Benefits:	Energy will be saved through removal of simultaneous heating and cooling
Baseline Documentation Method:	The following items were trended during the fall for the affected equipment (AHU-6, AHU-8, AHU-9, AHU-16, AHU-26, AHU-28, AHU-29, AHU-30) were analyzed: Cooling Valve, Heating Valve, Mixed Air Temperature, Heating Coil Temperature. In the trend log for each affect equipment (AHU-6f.xls, AHU-8 f.xls, AHU-9 f.xls, AHU-16 f.xls, AHU-26 f.xls, AHU-28 f.xls, AHU-29 f.xls, AHU-30 f.xls) times were identified when both the heating valve and the cooling valve were open at the same time. These trends were also used to determine the amount of time both the heating valve and the cooling valve were open at the same time. The chiller is engaged when the OSA is over 50ÂºF and the hot water loop is disengaged when the OSA is over 60ÂºF per the automation system and the valve positions were looked at during these temperature ranges. When both valves were found to be open, the difference between the mixed air temperature and the heating coil temperature was calculated. These values where then averaged to determine the average wasted energy for the equipment.		
Measure:	Adjust BMS programing and/or repair valves as necessary.		
Recommendation for Implementation:	The contractor shall adjust BMS programming to prevent the system from opening both the heating and cooling valves at the same time. The contractor shall also examine the valve actuator and adjust/or replace valve actuator on affected air handlers (AHU-6, AHU-8, AHU-9, AHU-16, AHU-26, AHU-28, AHU-29, AHU-30) as necessary to ensure that when closed no water flows through air handler coil.		
Evidence of Implementation Method:	Verification of Implementation shall require: The following trend logs of each of the affected air handlers (AHU-6, AHU-8, AHU-9, AHU-16, AHU-26, AHU-28, AHU-29, AHU-30) shall be taken on 15 minute intervals for 2 week(s) to verify that the valve modifications to eliminate simultaneous heating and cooling: Heating coil valve(s), Cooling coil valve(s), Mixed air temperature, Heating/Cooling coil temperature.		

Annual Electric Savings (kWh):	5,846	Annual Natural Gas Savings (therms):	209
Estimated Annual kWh Savings ($):	$356	Estimated Annual Natural Gas Savings ($):	$112
Contractor Cost ($):	4,040		
PBEEEP Provider Cost for Implementation Assistance ($):	1,870		
Total Estimated Implementation Cost ($):	$5,910		

Estimated Annual Total Savings ($):	$469	Utility Co-Funding for kWh ($):	$0
Initial Simple Payback (years):	12.61	Utility Co-Funding for kW ($):	$0
Simple Payback w/ Utility Co-Funding (years):	12.61	Utility Co-Funding for therms ($):	$0
GHG Avoided in U.S. Tons (C02e):	6	Utility Co-Funding - Estimated Total ($):	$0

Current Project as Percentage of Total project			
Percent Savings (Costs basis)	0.7%	Percent of Implementation Costs:	5.6%

PBEEEP was made possible with funding from the U.S. Department of Energy and the MN Department of Commerce.

Findings Details

PBEEEP State Government

Site: MN History Center

FWB Number:	10800	Eco Number:	11
Building:	Minnesota History Center	Date/Time Created:	9/26/2011

Investigation Finding:	Over Ventilation	Date Identified:	11/16/2010
Description of Finding:	Multiple pieces of equipment provide higher levels of outside air than is required for the space it serves. The equipment affected is: AHU-3, AHU-12		
Equipment or System(s):	AHU with heating and cooling	Finding Category:	Economizer/Outside Air Loads
Finding Type:	Over-Ventilation - Outside air damper failed in an open position. Minimum outside air fraction not set to design specifications or occupancy.		

Implementer:	Contractor	Benefits:	Air handling units will only bring in the minimum required outside air which elimintes excess heating/cooling.
Baseline Documentation Method:	The following items were trended during the fall for the affected equipment (AHU-3, AHU-12): OSA Damper Position, Min OSA Damper Position, Return Air Damper Position, Mixed Air Temp, Return Air Temp, and OSA Temp. The OSA % was calculated by first verifying that the OSA temperature was below 45Â°F to ensure the unit is not economizing. The OSA % was calculated with the following formula OSA% = (Mixed Air Temp â€“ Return Air Temp)/(OSA Temp â€“ Return Air Temp). These values were then averaged over the entire trending period (AHU-3f.xls, AHU-12f.xls). This calculated value was compared to the ASHRAE 62.1 required OSA flow (ASHRAE OSA Calcs.xls) to determine that the spaces were over ventilated. These spaces are electrical rooms that have a very low requirement for OSA flow.		
Measure:	OSA damper minimum setpoints will be adjusted in the field and in the BMS. Contractor shall verify damper operation.		
Recommendation for Implementation:	The Contractor shall adjust BMS programming to reduce the minimum open position of the OSA dampers such that amount of outside air brought into the unit meets the AHSRAE 62.1 Standards (AHU-3 shall be 5%, AHU-12 shall be 3%) during occupied periods. The minimum OSA flow and operation of the OSA damper shall be verified by a Test & Balance contractor after BMS adjustments have been made.		
Evidence of Implementation Method:	Verification of Implementation shall require: The final Test & Balance report from implementation will show that the minimum OSA airflow for the affected equipment (AHU-3, AHU-12) have been adjusted per requirements. Additionally, the following trend logs of each of the affected air handlers (AHU-3, AHU-12) can be taken on 15 minute intervals for 2 week(s) to verify that the modifications have been made: OSA damper(s), Air handler occupied/unoccupied status, OSA temperature, Return air temperature, Mixed air temperature.		

Annual Electric Savings (kWh):	664	Peak Demand Savings (kWh):	8
Estimated Annual kWh Savings ($):	$49	Estimated Annual Demand Savings ($):	$226
Contractor Cost ($):	600		
PBEEEP Provider Cost for Implementation Assistance ($):	0		
Total Estimated Implementation Cost ($):	$600		

Estimated Annual Total Savings ($):	$275	Utility Co-Funding for kWh ($):	$0
Initial Simple Payback (years):	2.18	Utility Co-Funding for kW ($):	$0
Simple Payback w/ Utility Co-Funding (years):	2.18	Utility Co-Funding for therms ($):	$0
GHG Avoided in U.S. Tons (C02e):	1	Utility Co-Funding - Estimated Total ($):	$0

Current Project as Percentage of Total project			
Percent Savings (Costs basis)	0.4%	Percent of Implementation Costs:	0.6%

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Findings Details

PBEEEP State Government

Site: MN History Center

FWB Number:	10800	Eco Number:	18
Building:	Minnesota History Center	Date/Time Created:	9/26/2011

Investigation Finding:	Unsealed holes in air handler supply ductwork	Date Identified:	4/1/2011
Description of Finding:	Test holes in ductwork from Test & Balance work left unpluged. This allows air to escape the system and increases fan energy needs. The equipment affected is: AHU-7, AHU-26		
Equipment or System(s):	AHU with heating and cooling	Finding Category:	Maintenance Related Problems
Finding Type:	Other Maintenance		

Implementer:	Owner	Benefits:	Reduced leakage will reduce fan energy usages
Baseline Documentation Method:	Site observations of the existing holes in ductwork.		
Measure:	Owner should patch holes in ductwork		
Recommendation for Implementation:	Maintenace department will patch the whole with either foil backed tape, duct mastic, or plastic plugs. The cost of the materials is negligable and will not be included. Implementation cost based on 0.5 hours of maintenance department work		
Evidence of Implementation Method:	Verification of Implementation shall require: Visual inspection of the affected air handlers to verify that the holes/leaks have been patched.		

Annual Electric Savings (kWh):	405	Annual Natural Gas Savings (therms):	5
Estimated Annual kWh Savings ($):	$25	Estimated Annual Natural Gas Savings ($):	$3
Contractor Cost ($):	50		
PBEEEP Provider Cost for Implementation Assistance ($):	0		
Total Estimated Implementation Cost ($):	$50		

Estimated Annual Total Savings ($):	$28	Utility Co-Funding for kWh ($):	$0
Initial Simple Payback (years):	1.81	Utility Co-Funding for kW ($):	$0
Simple Payback w/ Utility Co-Funding (years):	1.81	Utility Co-Funding for therms ($):	$0
GHG Avoided in U.S. Tons (C02e):	0	Utility Co-Funding - Estimated Total ($):	$0

Current Project as Percentage of Total project			
Percent Savings (Costs basis)	0.0%	Percent of Implementation Costs:	0.0%

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Findings Details

PBEEEP State Government

Site: MN History Center

FWB Number:	10800	Eco Number:	20
Building:	Minnesota History Center	Date/Time Created:	9/26/2011

Investigation Finding:	No hot water supply temperature reset active on boilers	Date Identified:	4/1/2011
Description of Finding:	Currently the boiler system at the facility does not include provisions for hot water supply temperature reset. The supply water temperature is fixed at 180ÂºF all the time.		
Equipment or System(s):	Boiler Plant	Finding Category:	Controls (Reset Schedules)
Finding Type:	HW Supply Temperature Reset is not implemented or is sub-optimal		

Implementer:	Contractor	Benefits:	Adjusting hot water supply temperature will lessen heat loss through piping in unconditioned space
Baseline Documentation Method:	The existing sequence of operations for the affected equipment (B-1, B-2, B-3) were collected from the BMS system and verified with trending of the Boiler Return Water Temperatures (B-1, B-2, B-3), Boiler Supply Water Temperatures (B-1, B-2, B-3), 180 HWS, 180 HWE ,and OSA temperature (Hot Water System - Winter.xls) during the winter to determine that the affect equipment does not use a hot water supply temperature reset when outside conditions would merit it.		
Measure:	Adjust BMS programing for boiler hot water supply temperature reset schedule		
Recommendation for Implementation:	The Contractor shall adjust BMS programing to allow boiler hot water supply temperature to reset between 150ÂºF and 180ÂºF based on an outside air temperature range of 0ÂºF to 55ÂºF.		
Evidence of Implementation Method:	Verification of Implementation shall require: The following trend logs of each of the affected boilers (B-1, B-2, B-3) shall be taken on 15 minute intervals for 2 week(s) to verify that the boiler water discharge temperature sequence has been modified: Boiler status, Boiler intake water temperature, Boiler discharge water temperature, Boiler discharge water temperature set-point, 180 Hot water return temperature, 180 Hot water supply temperature, 180 Hot water supply temperature set-point, VAV Hot water return temperature, VAV Hot water supply temperature, VAV Hot water supply temperature set-point.		

Annual Natural Gas Savings (therms):	632	Contractor Cost ($):	400
Estimated Annual Natural Gas Savings ($):	$339	PBEEEP Provider Cost for Implementation Assistance ($):	1,870
		Total Estimated Implementation Cost ($):	$2,270

Estimated Annual Total Savings ($):	$339	Utility Co-Funding for kWh ($):	$0
Initial Simple Payback (years):	6.70	Utility Co-Funding for kW ($):	$0
Simple Payback w/ Utility Co-Funding (years):	6.70	Utility Co-Funding for therms ($):	$0
GHG Avoided in U.S. Tons (C02e):	4	Utility Co-Funding - Estimated Total ($):	$0

Current Project as Percentage of Total project			
Percent Savings (Costs basis)	0.5%	Percent of Implementation Costs:	2.1%

PBEEEP was made possible with funding from the U.S. Department of Energy and the MN Department of Commerce.

PBEEEP State Government **History Center**

This checklist is designed to be a resource and reference for Providers and PBEEEP.

Finding Category	Finding Type Number	Finding Type	Relevant Findings (if any)	Finding Location	Reason for no relevant finding	Notes
a. Equipment Scheduling and Enabling:	a.1 (1)	Time of Day enabling is excessive	Units with schedules that don't match current use	Air Handlers (8, 16, 17, 18, 29) & Exhaust Fans (1, 5, 6, 25)		
	a.2 (2)	Equipment is enabled regardless of need, or such enabling is excessive	Kitchen exhaust hoods active when kitchen is closed	Exhaust Fans (2, 3, 4)		
	a.3 (3)	Lighting is on more hours than necessary.	N/A		Not Relevant	Lighting controls/upgrade are being done by the facility under a separate project. No lighting changes will be recommended under this investigation.
	a.4 (4)	OTHER_Equipment Scheduling/Enabling	N/A		Investigation looked for, but did not find this issue.	All scheduling items found under findings 1,2
b. Economizer/Outside Air Loads:	b.1 (5)	Economizer Operation – Inadequate Free Cooling (Damper failed in minimum or closed position, economizer setpoints not optimized)	Units do not have economizer mode	Air Handlers (19, 20, 21)		
	b.2 (6)	Over-Ventilation – Outside air damper failed in an open position. Minimum outside air fraction not set to design specifications or occupancy.	Units provide more OSA at minimum than required	Air Handlers (3,11)		
	b.3 (7)	OTHER_Economizer/OA Loads	Units do not use CO2 monitoring for OSA control	Air Handlers (19, 20, 21)		
c. Controls Problems:	c.1 (8)	Simultaneous Heating and Cooling is present and excessive	Unit found with heating & cooling valves open	Air handlers (6, 8, 9, 16, 26, 28, 29, 30)		
	c.2 (9)	Sensor/Thermostat needs calibration, relocation/shielding, and/or replacement	N/A		Investigation looked for, but did not find this issue.	
	c.3 (10)	Controls "hunt" and/or need Loop Tuning or separation of heating/cooling setpoints	N/A		Investigation looked for, but did not find this issue.	Several actuators controlling valves are over actuating (rapidly opening and closing). This is not causing additional energy use, but will cause the actuators to wear out faster than necessary. These actuators will be identified in the final report for the Owner to adjust.
	c.4 (11)	OTHER_Controls	N/A		Investigation looked for, but did not find this issue.	All control items found fall under findings 8,9,10
d. Controls (Setpoint Changes):	d.1 (12)	Daylighting controls or occupancy sensors need optimization.	N/A		Not Relevant	Lighting controls/upgrade are being done by the facility under a separate project. No lighting changes will be recommended under this investigation.
	d.2 (13)	Zone setpoint setup/setback are not implemented or are sub-optimal.	Units with not unoccupied setback	Air handlers (10,11,19, 20, 21, 26, 27, 30)		
	d.3 (14)	Fan Speed Doesn't Vary Sufficiently	N/A		Investigation looked for, but did not find this issue.	All fans with VFD vary acceptably as required by current sequence of operations.
	d.4 (15)	Pump Speed Doesn't Vary Sufficiently	N/A		Investigation looked for, but did not find this issue.	All pumps with VFD vary acceptably as required by current sequence of operations.
	d.5 (16)	VAV Box Minimum Flow Setpoint is higher than necessary	N/A		Investigation looked for, but did not find this issue.	Building VAV box flow rates were recalculated and rebalanced for the control system changes in 2009. The current code required minimum OSA levels (which directly affects VAV box minimums) are not lower than those in affect in 2009.
	d.6 (17)	Other_Controls (Setpoint Changes)	N/A		Investigation looked for, but did not find this issue.	All control items found fall under findings 12,13,14,15,16
e. Controls (Reset Schedules):	e.1 (18)	HW Supply Temperature Reset is not implemented or is sub-optimal	N/A		Investigation looked for, but did not find this issue.	Boiler 4 is used for steam generation and therefore cannot have a supply temp reset activated
	e.2 (19)	CHW Supply Temperature Reset is not implemented or is sub-optimal	N/A		Investigation looked for, but did not find this issue.	Facility has CHW Supply Temp Reset
	e.3 (20)	Supply Air Temperature Reset is not implemented or is sub-optimal	N/A		Investigation looked for, but did not find this issue.	Facility has Supply Air Temp Reset on all applicable air handlers
	e.4 ( )	Supply Duct Static Pressure Reset is not implemented or is sub-optimal	N/A		Investigation looked for, but did not find this issue.	Facility has Supply Pressure Reset on all applicable air handlers
	e.5 (21)	Condenser Water Temperature Reset is not implemented or is sub-optimal	Current condenser water reset is sub-optimal	Chillers (1,2,3,4) & Cooing Towers (1,2)		Current condenser water reset is sub-optimal
	e.6 (22)	Other_Controls (Reset Schedules)	N/A		Investigation looked for, but did not find this issue.	All reset schedule items found under findings 18,19,20,21
f. Equipment Efficiency Improvements / Load Reduction:	f.1 (23)	Daylighting Control needs optimization—Spaces are Over-Lit	N/A		Not Relevant	Lighting controls/upgrade are being done by the facility under a separate project. No lighting changes will be recommended under this investigation.
	f.2 (24)	Pump Discharge Throttled	N/A		Investigation looked for, but did not find this issue.	All pump duscharge valves for operating pumps were fully open on inspection
	f.3 (25)	Over-Pumping	N/A		Investigation looked for, but did not find this issue.	All instances of Over-pumping have been addressed by adding a VFD to the pumps. See that Finding for resulting calculations.
	f.4 (26)	Equipment is oversized for load.	N/A		Investigation looked for, but did not find this issue.	
	f.5 (27)	OTHER_Equipment Efficiency/Load Reduction				All equipment efficiency improvements/load reduction items found under findings 23,24,25,26
g. Variable Frequency Drives (VFD):	g.1 (28)	VFD Retrofit - Fans	Certain air handlers that are constant volume serve a single space. These units could be retrofit with a VFD for fan control	Air handlers (3,8,11,12,17,18,26,30,31)		
	g.2 (29)	VFD Retrofit - Pumps	Certain constant volume pumps can be modified with a VFD and be allowed to run slower when building demand is low	P-7, P-8		
	g.3 (30)	VFD Retrofit - Motors (process)	N/A		Not Relevant	No process motors on this site
	g.4 (31)	OTHER_VFD	N/A		Investigation looked for, but did not find this issue.	All VFD items found under findings 28,29,30
	h.1 (32)	Retrofit - Motors	N/A		Not cost-effective to investigate	Motors on site are all high effenciy or better.

PBEEEP State Government History Center

This checklist is designed to be a resource and reference for Providers and PBEEEP.

Finding Category	Finding Type Number	Finding Type	Relevant Findings (if any)	Finding Location	Reason for no relevant finding	Notes
h. Retrofits:	h.2 (33)	Retrofit - Chillers	N/A		Not cost-effective to investigate	Current chilelrs are in good repair and replacement will not have a payback within PBEEEP Program time span
	h.3 (34)	Retrofit - Air Conditioners (Air Handling Units, Packaged Unitary Equipment)	N/A		Not Relevant	No packaged equipment on this site.
	h.4 (35)	Retrofit - Boilers	N/A		Not cost-effective to investigate	Current boilers are in good repair and replacement will not have a payback within PBEEEP Program time span
	h.5 (36)	Retrofit - Packaged Gas fired heating	N/A		Not Relevant	No packaged gas fired equipment on this site.
	h.6 (37)	Retrofit - Heat Pumps	N/A		Not Relevant	No heat pump equipment on this site.
	h.7 (38)	Retrofit - Equipment (custom)	N/A		Investigation looked for, but did not find this issue.	All retrofit items found under findings 32,33,34,35,36
	h.8 (39)	Retrofit - Pumping distribution method	N/A		Investigation looked for, but did not find this issue.	HW and CHW systems are all ready primary/secondary systems.
	h.9 (40)	Retrofit - Energy/Heat Recovery				
	h.10 (41)	Retrofit - System (custom)			Not Relevant	All retrofit items found fall under other Findings
	h.11 (42)	Retrofit - Efficient Lighting	N/A		Not Relevant	Lighting controls/upgrade are being done by the facility under a separate project. No lighting changes will be recommended under this investigation.
	h.12 (43)	Retrofit - Building Envelope	N/A		Not cost-effective to investigate	Building is all finished space and not cost effective to retrofit the building envelope.
	h.13 (44)	Retrofit - Alternative Energy	N/A		Not cost-effective to investigate	Simple calculations show that on site photovoltaic energy generation would have a payback period exceeding 50 years. Solar-thermal energy generation was not investigated as the facility has a low domestic hot water load and currently uses a heat recovery chiller to provide reheat water for VAV boxes during the summer.
	h.14 (45)	OTHER Retrofit	N/A		Not Relevant	
i. Maintenance Related Problems:	i.1 (46)	Differed Maintenance from Recommended/Standard	N/A		Investigation looked for, but did not find this issue.	Several differed maintenance type findings have been identified throughout this investigation. None of them provide solid energy savings. These items are identified in the final report for the Owner to examine and implement as time allows.
	i.2 (47)	Impurity/Contamination	N/A		Investigation looked for, but did not find this issue.	
	i.3 ( )	Leaky/Stuck Damper				
	i.4 ( )	Leaky/Stuck Valve	N/A		Investigation looked for, but did not find this issue.	Any stuck heating/cooling coil valves were identified in the Simultaneous heating/cooling finding.
	i.5 (48)	OTHER Maintenance	YES	Air Handlers (7,26)		Holes found in ductwork that need to be sealed. Dampers that do no fully close.
j. OTHER	j.1 (49)	OTHER			Investigation looked for, but did not find this issue.	

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June 30, 2011

MN Department of Administration
Real Estate and Construction Services
Mr. Larry Nichols
309 Administration Building
50 Sherburne Ave.
St Paul MN 55155

Re: PBEEP History Center: RECS Project#02651HCD

Mr. Nichols:

During our Investigation for the PBEEEP Energy Study at the Minnesota History Center, we have identified several maintenance related items. These items do not necessarily save energy money and therefore are not included in the PBEEEP Findings Workbook. They may however save maintenance money (The current PBEEEP Program does not allow maintenance money to be included when calculating the benefits of an Energy Conservation Opportunity) and may be pursued at the Owner's convenience.

Overactive Actuators: The following is a list of actuators at the facility that appear to be overly active in their controls. They seem to modulate widely in a very short time frame. This does not appear to affect the equipment's ability to control air temperatures. It merely means that the actuators are over active and may be wearing out prematurely. We recommend that the Owner examines the control loops for the following actuators to determine which may need to be slowed down to prevent overactive actuation.

- Air Handler 4
  - Cooling Coil D Valve
- Air Handler 6
  - Heating Coil Valve
- Air Handler 12
  - Cooling Coil Valve (This was only overactive for a short time during our trending)
- Air Handler 15
  - Cooling Coil Valve
- Air Handler 20
  - Heating Coil Valve
- Air Handler 21
  - Heating Coil Valve
- Air Handler 22
  - Heating Coil Valve
- Air Handler 23
  - Cooling Coil Valve
- Air Handler 25
  - Cooling Coil Valve
- Air Handler 26
  - Heating Coil Valve
  - Cooling Coil Valve
- Air Handler 27

    - Cooling Coil Valve
- Air Handler 30
    - Cooling Coil Valve

Sincerely,

Matthew Armstead, PE

Air Handler 32

- Cooling Coil Valve
- RM507 Heating Coil Valve
- RM508 Heating Coil Valve

Heat Exchangers: Recently the facility has stopped using the cooling towers and heat exchangers during the winter for free cooling. There were icing issues and this system required a lot of maintenance to ensure proper operation. The facility is now utilizing an economizer style mode during the winter to provide cooling for those air handlers that required winter cooling. If these heat exchangers will no longer be used, we recommend that the facility closes all isolation valves on the heat exchangers to prevent any accidental heat transfer from the chilled water to the condenser water.

Freeze-stat Failures: During our investigation, EEA manually tested the operation of the freeze-stat for all of the air handlers at the facility. When a freeze-stat trips, the OSA damper should close, the fan(s) should deactivate, and the heating coil valve should modulate open. Information about improperly operating freeze-stats was presented to the Owner in early winter. These issues may have all ready been addressed, but we feel it is important that these items be checked.

- AHU-7 – OSA damper did not close on freeze-stat trip
- AHU-8 – OSA damper did not close on freeze-stat trip
- AHU-10 – No alarm on the BMS on freeze-stat trip
- AHU-11 – No freeze stat installed (this is a 100% OSA unit)
- AHU-16 – No alarm on the BMS on freeze-stat trip

Sincerely,

Matthew E. Armstead, PE

Public Buildings Enhanced Energy Efficiency Program

SCREENING RESULTS FOR Minnesota History Center

Date: 4/27/2010

Summary Table

Facility Name	History Center
Location	345 Kellogg Blvd W St. Paul, MN 55102
Facility Manager	Gene Peterman
Number of Buildings	1
Interior Square Footage	492,097
PBEEEP Provider	CEE (Neal Ray)
State's Project Manager	Larry Nichols
Date Visited	April 5, 2010
Annual Energy Cost	$893,695 (2009)
Utility Company	Xcel Energy: Electric and Natural Gas
Site Energy Use Index (EUI)	159 kBtu/ft^2
Benchmark EUI (from B3)	176 KBtu/ft^2

Recommendation for Investigation

A full investigation of the Minnesota History Center is recommended.

Building Name	State ID	Area (Square Feet)	Year Built
Minnesota History Center	E4002502501	492,097	1992

MN History Center Screening Overview

The goal of screening is to select buildings where an in-depth energy investigation can be performed to identify energy savings opportunities that will generate savings with a relatively fast (1 to 5 years) and certain payback. The screening of the Minnesota History Center was performed by the Center for Energy and Environment (CEE) with the assistance of the facility staff. This report is the result of that information.

The Minnesota History Center is one large building consisting of 492,097 interior square feet. The building runs on a Honeywell EBI automation system. All equipment is on the automation system except several CUH and UHs, which are controlled by manual thermostats on the wall. The building was constructed in 1992. There was a recent HVAC upgrade to the sequences and automation system, which is just about complete. The building was also tested and balanced at this time. The building has never had any projects commissioned or retrocommissioned. The facility just recently had a lighting audit performed on it with energy saving recommendations as well; this study will be a source of measures to be considered for implementation under PBEEEP.

The building contains a total of four chillers, one of which does not work (there are no plans to put it back in service). Two are used to supply chilled water to cooling coils in all the AHUs for cooling. The third chiller supplies chilled water to units serving artifacts areas, this chiller needs to produce chilled water at a lower temperature then the two other chillers in order to meet strict temperature and humidity requirements in the space. These chillers are connected to two large cooling towers.

There are four gas fired boilers, which use fuel oil as a backup fuel source. Three boilers are used to supply hot water to AHUs hot water coils and VAV reheat coils. These three boilers are identical and each is rated at 6,695 kBtu/hr and delivers hot water at around 180 ºF. The other boiler is used to generate steam for humidity and is rated at 5,021 kBtu/hr.

There are a total of 31 AHUs serving all the spaces within the History Center: Ten of the AHUs are constant volume, nine are multi-zone units, four are dual duct, and eight are variable air volume units with VAV boxes.

The space uses vary significantly throughout the building. The building includes museum space and storage of artifacts which require specific temperature and humidity conditions at all times. There are a total of six floors. The first two floors, floors (A and B) are mostly office, research and storage space. The next floor (Level 1) consists of a large café which serves food to the public and employees and an auditorium, and gift shop, The upper three floors (Levels 2, 3 and 4) consist of galleries which have artifacts and displays for the public to view, classrooms, office space and two libraries . There are three large open atriums that run from levels 1 through 4 in the building as well. These open areas not only contain other displays for the public to view, but are also rented out for private parties and formal events such as weddings.

There are two gas meters, one interruptible and one firm; and one electrical meter.

PBEEEP Screening Report of MN History Center PBEEEP # P10800

This screening report is based on the PBEEEP Guidelines. It is based on one site visit, review of the facility documentation, building automation system, a limited inspection of the facility and interviews with the staff. The purpose of the screening report is to evaluate the potential of the facility for the implementation of cost-effective energy efficiency savings through recommissioning. To the best of our knowledge the information here is accurate. It provides a high level view of many, but by no means all, of the important parameters of the mechanical equipment in the facility. Because it is the result of a limited audit survey of the facility, it may not be completely accurate.

MN History Center				State ID#	
Area (sqft)	492,097	Year Built	1992	Occupancy (hrs/yr)	3800

HVAC Equipment

- **4 Chillers:** 2 rated at 640 tons, one rated at 320 tons, and one that does not work with a unknown rating
- **2 Cooling Towers**
- **2 Cooling Tower Fans:** 100 HP with VFD
- **4 Secondary Chilled Water Pumps:** 2 for the two 640 ton chillers rated at 60 HP with VFDs, 2 pumps for the 320 ton chiller rated at 30 HP.
- **3 Condenser Pumps:** 2 at 60 HP and one at 25 HP. Condenser pump for chiller 3 is not used and the HP is unknown
- **4 Boilers:** 3 used to produce hot water for AHUs and reheats rated at 6695 MBH, one used for steam to generate humidity rated at 5021 MBH
- **4 Secondary Hot Water Pumps**: 2 rated at 25 HP and 2 rated at 50HP all with VFDs
- **4 Primary Hot Water Pumps**: rated at 10 HP
- **31 AHUs**

AHU -1A-1	46,800 CFM	40 HP SF 15 HP RF	Multi-zone unit	7 Zones, one does not contain a heating coil
AHU-1B-2	12,400 CFM	20 HP SF 7.5 HP RF	Multi-zone unit	6 Zones
AHU-2A-3	12,000 CFM	10 HP SF	CV	Single Zone, electrical room
AHU-2B-4	17,500 CFM	25 HP SF 10 HP RF	Multi-zone unit	5 Zones, one does not contain a heating coil
AHU-1E-5	7,700 CFM	15 HP SF	Multi-zone	3 Zones

		5 HP RF	unit	
AHU-2A-6	22,000 CFM	30 HP SF 15 HP RF	VAV, VFD	29 VAV boxes ranging in capacity from 240 to 1400 CFM
AHU-2A-7	18,500 CFM	30 HP SF 7.5 HP RF	VAV, VFD	3 VAV boxes and 17 MAUs attached to AHU
AHU-2A-8	9,000 CFM	15 HP SF 5 HP RF	CV	Serves one room
AHU-2E-9	48,300 CFM	75 HP SF 30 HP RF	VAV, VFD	45 VAV boxes with capacities ranging from 210 to 2250 CFM
AHU-2E-10	12,000 CFM	20 HP SF 5 HP RF	VAV, VFD	17 VAV boxes with capacities ranging from 120 to 2400 CFM
AHU-2E-11	10,000 CFM	10 HP SF	CV	Boiler Room
AHU-2E-12	12,000 CFM	10 HP SF	CV	Electrical Room
AHU-3A-13	25,900 CFM	40 HP SF 15 HP RF	Multi-zone unit	4 Zones
AHU-3C-15	27,400 CFM	40 HP SF 20 HP RF	Multi-zone unit	6 zones
AHU-3C-16	14,000 CFM	20 HP SF 5 HP RF	VAV, VFD	8 VAV boxes with CFMs ranging from 810 to 2000 CFM
AHU-2E-17	3,500 CFM	5 HP SF 3 HP RF	CV	Serves room 323
AHU-2E-18	5,000 CFM	7.5 HP SF 3.0 HP RF	CV	
AHU-4A-19	15,700 CFM	25 HP SF 10 HP RF	Dual Duct VAV	14 VAV boxes ranging in size from 520 to 1660 CFM
AHU-4B-20	15,700 CFM	30 HP SF unknown RF HP	Dual Duct VAV	10 VAV boxes ranging in size from 920 to 2040 CFM

AHU-4B-21	12,400 CFM	25 HP SF 7.5 HP RF	Dual Duct VAV	7 VAV boxes ranging in size from 1010 to 2720 CFM
AHU-4C-22	19,300 CFM	40 HP SF 10 HP RF	Dual Duct VAV	16 VAV boxes ranging in size from 260 to 2690 CFM
AHU-5A-23	27,000 CFM	50 HP SF 15 HP RF	Multi-zone unit	4 Zones
AHU-5B-24	33,300 CFM	50 HP SF 25 HP RF	Multi-zone unit	6 Zones
AHU-5B-25	36,000 CFM	60 HP SF 25 HP RF	Multi-zone unit	6 Zones
AHU-6B-26	7500 CFM	10 HP SF 5 HP RF	CV	Serves one space
AHU-6B-27	58,000 CFM	100 HP SF 30 HP RF	VAV, VFD	50 VAV boxes ranging in capacity from 300 to 2250 CFM
AHU-7A-28	24,800 CFM	unknown motor HPs	VAV, VFD	28 VAV boxes ranging in capacity from 150 to 1790 CFM
AHU-7B-29	17,500 CFM	30 HP SF 10 HP RF	VAV, VFD	20 VAV boxes ranging in capacity from 400 to 1300 CFM
AHU-7B-30	12,900 CFM	20 HP SF 7.5 HP RF	CV	Serves one space
AHU-2E-31	10,000 CFM	7.5 HP SF 3.0 HP RF	CV	Serves Chiller Room
AHU-5B-32	2,840 CFM	5 HP SF 3 HP RF	CV	Serves Chiller Room

- **27 Exhaust Fans**: Ratings between 220 to 5000 CFM
- **6 FCUs**
- **4 Domestic Hot Water Pumps**
- **9 Sump Pumps**
- **Several cabinet unit and unit heaters**

Points on BAS
- **AHU**: OA damper percentage, MAT, MAT low limit, cooling valve percentage, DAT, DAT setpoint, SF status, RF status, RAT, RARH, hot water valve percentage, return damper percentage, relief damper percentage, bypass damper percentage, OAT, OARH - **VAV:** Room Temperature, Room setpoint, Reheat Valve, Airflow, Airflow setpoint, Damper position - **Chiller:** CHWST, CHWRT, CDWST, CDWRT, Evaporator Pump Status, Condenser Pump Status, Heat Exchanger Valves - **Chilled Water Pumps:** DP, DP setpoint, pump status, pump command, speed - **Boiler:** boiler status, boiler command, pump status, HWS, HWR, VAV HWS, VAV HWR, HWDP, HW flow - **Exhaust Fan:** fan status, fan command, damper - **FCU:** room temperature, room temperature setpoint, fan status, cooling valve percentage - **Steam Generator:** HWS, HWR, hot water flow, stream pressure - **Electric Fin Tube Radiation:** system enable, outside enable setpoint, space temperature, space temperature setpoint - **Misc. Points:** domestic HW pump status, domestic HWS, sump pump status

Additional comments by building staff

- The AHUs which serve artifact spaces and galleries never economize, they just allow the minimum amount of OA (AHU-1, AHU-2, AHU-4, AHU-5, AHU-13, AHU-15, AHU-23, AHU-24)
- When different exhibits are brought in and displayed space conditions have to be altered accordingly
- Hot water supply temperature from the boilers is never reset; the set point is about 180 ºF

PBEEEP Abbreviation Descriptions			
AHU	Air Handling Unit	FCU	Fan Coil Unit
BAS	Building Automation System	HW	Hot Water
CAV	Constant Air Volume	HDP	Hot Water Differential Pressure
CDW	Condenser Water	HWR	Hot Water Return Temperature
CDWRT	Condenser Water Return Temperature	HWS	Hot Water Supply Temperature
CDWST	Condenser Water Supply Temperature	MA	Mixed Air
CFM	Cubic Feet per Minute	MAT	Mixed Air Temperature
CHW	Chilled Water	MAU	Make-up Air Unit
CHWRT	Chilled Water Return Temperature	OA	Outside Air
CHWST	Chilled Water Supply Temperature	OARH	Outside Air Relative Humidity
CRAC	Computer Room Air Conditioner	OAT	Outside Air Temperature
CV	Constant Volume	RA	Return Air
DA	Discharge Air	RAT	Return Air Temperature
DAT	Discharge Air Temperature	RF	Return Fan
DDC	Direct Digital Control	RH	Relative Humidity
DP	Differential Pressure	RTU	Rooftop Unit
DX	Direct Expansion	SF	Supply Fan
EA	Exhaust Air	Unocc	Unoccupied
Econ	Economizer	VAV	Variable Air Volume
EF	Exhaust Fan	VFD	Variable Frequency Drive
Enth	Enthalpy		

System Tag	Equipment Tag	Equipment Type	Manufacturer	Model #	Discription	Year Installed	Year Upgr	Upgrade/Refirb Discription	VFD	Capacity	Motor HP	Location	Current Schedule	Notes
-	Chiller 1	Chiller	Trane	N02D04847	Chiller for main cooling system	1992		Refrigerant Chang out	No	640 TON	-	Rm 103.5		
-	Chiller 2	Chiller	Trane	N97J06225	Chiller for main cooling system	1992		Refrigerant Chang out	No	640 TON	-	Rm 103.5		
-	Chiller 3	Chiller	Trane	L90C00677	Energy recovery chiller - Not functional	1992	-	-	No	400 TON	-	Rm 103.5		
-	Chiller 4	Chiller	Trane	L07B01014	Chiller for sub-cooling dehumidification system	1992		Refrigerant Chang out	No	320 TON	-	Rm 103.5		
-	North Cooling Tower 1	Cooling Tower	-		Cooling tower for Chiller 1 & Chiller 4	1992			Yes		100 HP	Outside		
-	South Cooling Tower 2	Cooling Tower	-		Cooling tower for Chiller 2 & Chiller 3	1992			Yes		100 HP	Outside		
-	Pump-01	Pump	B&G	6BC-8-3/4 BF	Hot water pump for Boiler 1	1992			No	1250 GPM	10 HP	Rm 103.8		
-	Pump-02	Pump	B&G	6BC-8-3/4 BF	Hot water pump for Boiler 2	1992			No	1250 GPM	10 HP	Rm 103.8		
-	Pump-03	Pump	B&G	1510 6BC	Hot water pump for Boiler 3	1992			No	1250 GPM	10 HP	Rm 103.8		
-	Pump-04	Pump	B&G	1510 BF 12.375	Hot water pump for Boiler 4 & 240°F system	1992			No	1100 GPM	50 HP	Rm 103.8		
-	Pump-04A	Pump	B&G	1510 BF 12.375	Hot water pump for Boiler 4 & 240°F system	1992			No	1100 GPM	50 HP	Rm 103.8		
-	Pump-05	Pump	B&G	1510 4E	Secondary hot water pump	1992			Yes	700 GPM	25 HP	Rm 103.8		
-	Pump-06	Pump	B&G	1510 4E	Secondary hot water pump	1992			Yes	700 GPM	25 HP	Rm 103.8		
-	Pump-07	Pump	B&G	5E-10-3/8 BFE	Secondary hot water pump for VAV Boxes	1992			No	760 GPM	30 HP	Rm 103.8		Currently no status or BMS control
-	Pump-08	Pump	B&G	5E-10-3/8 BFE	Secondary hot water pump for VAV Boxes	1992			No	760 GPM	30 HP	Rm 103.8		Currently no status or BMS control
-	Pump-09	Pump	B&G	6BC-7-5/8 BF	Evap Water Pump for Chiller 1	1992			Yes	1360 GPM	10 HP	Rm 103.5		
-	Pump-10	Pump	B&G	6BC-7-5/8 BF	Evap Water Pump for Chiller 2	1992			Yes	1360 GPM	10 HP	Rm 103.5		
-	Pump-11	Pump	B&G	5BC-7-1/8 BF	Evap Water Pump for Chiller 3	1992			Yes	840 GPM	10 HP	Rm 103.5		
-	Pump-12	Pump	B&G	3G-12-3/8 BF	Evap Water Pump for Chiller 4	1992			Yes	400 GPM	30 HP	Rm 103.5		
-	Pump-13	Pump	B&G	3G-12-3/8 BF	Evap Water Pump for Chiller 4	1992			Yes	400 GPM	30 HP	Rm 103.5		
-	Pump-14	Pump	B&G	6E-11-BF 88524P	Secondary Chilled Water Pump	1992			Yes	1800 GPM	60 HP	Rm 103.5		
-	Pump-15	Pump	B&G	6E-11-BF 88524P	Secondary Chilled Water Pump	1992			Yes	1800 GPM	60 HP	Rm 103.5		
-	Pump-16	Pump	PEERLESS	16 MC 1 STAGE	Condenser Water Pump for Chiller 1	1992			No	2100 GPM	60 HP			
-	Pump-17	Pump	PEERLESS	16 MC 1 STAGE	Condenser Water Pump for Chiller 2	1992			No	2100 GPM	60 HP			
-	Pump-18	Pump	PEERLESS	14LD 1-STAGE	Condenser Water Pump for Chiller 3	1992			No	1260 GPM	40 HP			
-	Pump-19	Pump	PEERLESS	12MB 2-STAGE	Condenser Water Pump for Chiller 4	1992			No	750 GPM	25 HP			
-	Pump-20	Pump	B&G	60 1-1/2A		1992			No	30 GPM	1 HP			
-	Pump-21	Pump	B&G	60 1-1/2A	HWS 180 Pump Monitoring Point	1992			No	30 GPM	1 HP			
-	Pump-22	Pump	B&G	60 1-1/2A		1992			No	15 GPM	1 HP			
-	Pump-23	Pump	B&G	60 1-1/2A	HWS 180 Pump Monitoring Point	1992			No	15 GPM	1 HP			
-	Pump-24	Pump	B&G	185264	HWS 180 Pump Monitoring Point	1992			No	50 GPM	2 HP	Rm 203.5		
-	Pump-25	Pump	B&G	185264	HWS 180 Pump Monitoring Point	1992			No	50 GPM	2 HP	Rm 203.5		
-	Pump-26	Pump	VIKING	HJ4195	Fuel Oil Pump	1992			No	20 GPM	1.5 HP			
-	PP-1	Pump	B&G	189105	Domestic Hot Water Pump	1992			No	5 GPM	0.17 HP	Rm 103.8		
-	PP-2	Pump	B&G	189105	Domestic Hot Water Pump	1992			No	5 GPM	0.17 HP	Rm 103.8		
-	PP-3	Pump	B&G	189105	Domestic Hot Water Pump	1992			No	5 GPM	0.17 HP			
-	PP-4	Pump	B&G	SERIES 100-3/4	Domestic Hot Water Pump	1992			No	5 GPM	0.08 HP			
-	PP-5	Pump	GOULD	GL-1ST05	Deionized Water Circ Pump	1992			No	10 GPM	0.5 HP			
-	GLP-2A	Pump	B&G	?	Glycol Loop Pump	1992			No	?	5 HP	Rm 203.5		
-	GLP-2B	Pump	B&G	?	Glycol Loop Pump	1992			No	?	5 HP	Rm 203.5		
-	Leibert P-1	Pump	Armstrong	4380 1.5x1.5x8	Leibert Unit Pumps	1992			No	28 GPM	1.5 HP	Rm 203.5	24 hrs / 7 days	
-	Leibert P-2	Pump	Armstrong	4380 1.5x1.5x8	Leibert Unit Pumps	1992			No	28 GPM	1.5 HP	Rm 203.5	24 hrs / 7 days	
-	Boiler 1	Boiler	Kewanee	L3W-200-G02	Boiler for main heating system	1992			No	3000/6695 MBH In/Ou	-	Rm 103.8		
-	Boiler 2	Boiler	Kewanee	L3W-200-G02	Boiler for main heating system	1992			No	3000/6695 MBH In/Ou	-	Rm 103.8		
-	Boiler 3	Boiler	Kewanee	L3W-200-G02	Boiler for main heating system	1992			No	3000/6695 MBH In/Ou	-	Rm 103.8		
-	Boiler 4	Boiler	Kewanee	H3W-150-G02	Boiler for humidification system	1992			No	5021 MBH	-	Rm 103.8		
AHU-1A-1	AHU-1A-1	Multi Zone Air Handler	SEMCO	-	Air Handler for Collection Storage	1992			-	-	-	Rm 103.1	24 hrs / 7 days	7 Zones, one does not
	S-1A-1	Supply Fan	SEMCO	365-AF CCW	AHU-1A-1 Supply Fan	1992			No	26800 CFM	40 HP			containg a heating coil
	R-1A-1	Return Fan	Bary Blower	445 TUB AF CW	AHU-1A-1 Return Fan	1992			No	24100 CFM	15 HP			
AHU-1B-2	AHU-1B-2	Multi Zone Air Handler	SEMCO	-	Air Handler for Collection Storage	1992			-	-	-	Rm 103.3	24 hrs / 7 days	6 Zones
	S-1B-2	Supply Fan	SEMCO	DWDI 245	AHU-1B-2 Supply Fan	1992			No	12400 CFM	20 HP			
	R-1B-2	Return Fan	Bary Blower	355 TUB AF CW	AHU-1B-2 Return Fan	1992			No	11200 CFM	7.5 HP			
AHU-2A-3	AHU-2A-3	Multi Zone Air Handler	MCQUAY	-	Air Handler for Electric Room 203.1	1992			-	-	-	Rm 203.1		Single Zone
	S-2A-3	Supply Fan	MCQUAY	LSL1128DH	AHU-2A-3 Supply Fan	1992			No	12000 CFM	10 HP			
AHU-2B-4	AHU-2B-4	Multi Zone Air Handler	SEMCO	-	Air Handler for Storage	1992			-	-	-	Rm 203.3		5 Zones one does not
	S-2B-4	Supply Fan	Bary Blower	DWDI 300	AHU-2B-4 Supply Fan	1992			No	17500 CFM	25 HP			contain a heating coil
	R-2B-4	Return Fan	Bary Blower	445 TUB AFCW	AHU-2B-4 Return Fan	1992			No	15700 CFM	10 HP			
AHU-1E-5	AHU-1E-5	Multi Zone Air Handler	SEMCO	-	Air Handler for A.V. Storage	1992			-	-	-	Rm 103.8	24 hrs / 7 days	3 Zones
	1E-5 CHWP	Chilled Water Pump	B&G	186863	AHU-1E-5 Chilled Water Pump	1992			No	14 GPM	0.25 HP			
	S-1E-5	Supply Fan	SEMCO	DWDI 182	AHU-1E-5 Supply Fan	1992			No	7700 CFM	15 HP			
	R-1E-5	Return Fan	Bary Blower	300 TUB AFCW	AHU-1E-5 Return Fan	1992			No	6900 CFM	10 HP			

System Tag	Equipment Tag	Equipment Type	Manufacturer	Model #	Discription	Year Installed	Year Upgr	Upgrade/Refirb Discription	VFD	Capacity	Motor HP	Location	Current Schedule	Notes
AHU-2A-6	AHU-2A-6	VAV Air Handler	SEMCO	-	Air Handler for 1st & 2nd Floor Office	1992			-	-	-	Rm 203.2	6:30 -15:30 M-F	29 VAV boxes ranging in capacity from 240 to 1400 CFM
	2A-6 HWP	Heating Water Pump	B&G		AHU-2A-6 Heating Water Pump	1992			No	54 GPM	0.25 HP			
	S-2A-6	Supply Fan	SEMCO	DWDI 330	AHU-2A-6 Supply Fan	1992			Yes	22000 CFM	30 HP			
	R-2A-6	Return Fan	Snyder General	330 AF CCW	AHU-2A-6 Return Fan	1992			Yes	19800 CFM	15 HP			
AHU-2A-7	AHU-2A-7	VAV Air Handler	SEMCO	-	Air Handler for Conservation Lab	1992			-	-	-	Rm 203.2	24 hrs / 7 days	3 VAV boxes and 17 MAU's attached to AHU
	2A-7 HWP	Heating Water Pump	B&G	Inaccessible	AHU-2A-7 Heating Water Pump	1992			No	86 GPM	0.25 HP			
	S-2A-7	Supply Fan	Bary Blower	270 DWDI	AHU-2A-7 Supply Fan	1992			Yes	18500 GPM	30 HP			
	R-2A-7	Return Fan	Snyder General	30J-RPK	AHU-2A-7 Return Fan	1992			Yes	10130 CFM	7.5 HP			
AHU-2A-8	AHU-2A-8	Const Volume Air Handler	SEMCO	-	Air Handler for Auditorium	1992			-	-	-	Rm 203.2	Does not run	Serves one room
	2A-8 HWP	Heating Water Pump	B&G	2 1/2 A00	AHU-2A-8 Heating Water Pump	1992			No	59 GPM	0.25 HP			
	S-2A-8	Supply Fan	SEMCO	DWDI 222	AHU-2A-8 Supply Fan	1992			No	9000 CFM	15 HP			
	R-2A-8	Return Fan	Bary Blower	222 AF CW	AHU-2A-8 Return Fan	1992			No	8100 CFM	5 HP			
AHU-2E-9	AHU-2E-9	VAV Air Handler	SEMCO	-	Air Handler for Collections Work Room	1992			-	-	-	Rm 203.5	24 hrs / 7 days	45 VAV boxes with capacities ranging from 210 to 2250 CFM
	2E-9 HWP	Heating Water Pump	B&G	Inaccessible	AHU-2E-9 Heating Water Pump	1992			No	94.8 GPM	0.75 HP			
	S-2E-9	Supply Fan	SEMCO	DWDJ 445	AHU-2E-9 Supply Fan	1992			Yes	48300 CFM	75 HP			
	R-2E-9	Return Fan	Bary Blower	TUB 542	AHU-2E-9 Return Fan	1992			Yes	40000 CFM	30 HP			
AHU-2E-10	AHU-2E-10	VAV Air Handler	MCQUAY	-	Air Handler for Travelling Exhibits	1992			-	-	-	Rm 203.5	24 hrs / 7 days	17 VAV boxes with capacities ranging from 120 to 2400 CFM
	2E-10 HWP	Heating Water Pump	B&G	189165	AHU-2E-10 Heating Water Pump	1992			No	27.9 GPM	0.17 HP			
	S-2E-10	Supply Fan	MCQUAY	MSL 128 DV	AHU-2E-10 Supply Fan	1992			Yes	12000 CFM	20 HP			
	R-2E-10	Return Fan	Bary Blower	270 TUB AF CW	AHU-2E-10 Return Fan	1992			Yes	6000 CFM	5 HP			
AHU-2E-11	AHU-2E-11	Const Volume Air Handler	MCQUAY	-	Air Handler for Boiler Room	1992			-	-	-	Rm 203.5	24 hrs / 7 days	Boiler Room
	2E-11 HWP	Heating Water Pump	B&G	-	AHU-2E-11 Heating Water Pump	1992			No	54 GPM	0.25 HP			
	S-2E-11	Supply Fan	MCQUAY	LSL122	AHU-2E-11 Supply Fan	1992			No	10000 CFM	10 HP			
AHU-2E-12	AHU-2E-12	Const Volume Air Handler	MCQUAY	-	Air Handler for Electric Room 203.5	1992			-		-	Rm 203.5	24 hrs / 7 days	Electrical Room
	S-2E-12	Supply Fan	MCQUAY	LSL128DV	AHU-2E-12 Supply Fan	1992			No	12000 CFM	10 HP			
AHU-3A-13	AHU-3A-13	Multi Zone Air Handler	SEMCO	-	Air Handler for Storage	1992			-	-	-	Rm 303.1	24 hrs /7 days	4 Zones
	3A-13 CHWP	Chilled Water Pump	B&G	Inaccessible	AHU-3A-13 Chilled Water Pump	1992			No	128 GPM	0.33 HP			
	S-3A-13	Supply Fan	Bary Blower	DWDI 365	AHU-3A-13 Supply Fan	1992			No	25900 CFM	40 HP			
	R-3A-13	Return Fan	Bary Blower	445 TUB	AHU-3A-13 Return Fan	1992			No	23300 CFM	15 HP			
AHU-3C-15	AHU-3C-15	Multi Zone Air Handler	SEMCO	-	Air Handler for Library Storage	1992			-	-	-	Rm 303.5	24 hrs / 7 days	6 Zones
	S-3C-15	Supply Fan	Bary Blower	DWDI 365	AHU-3C-15 Supply Fan	1992			No	27400 CFM	40 HP			
	R-3C-15	Return Fan	Bary Blower	445 TUB	AHU-3C-15 Return Fan	1992			No	25100 CFM	20 HP			
AHU-6C-16	AHU-6C-16	VAV Air Handler	SEMCO	-	Air Handler for Kitchen/Café	1992			-	-	-	Penthouse C	3:30-6:30 M-F	8 VAV boxes ranging in size from 520 to 1660 CFM
	6C-16 HWP	Heating Water Pump	B&G	189105	AHU-6C-16 Heating Water Pump	1992			No	28 GPM	0.33 HP			
	S-6C-16	Supply Fan	Snyder General	245 AF CW	AHU-6C-16 Supply Fan	1992			Yes	14000 CFM	20 HP			
	R-6C-16	Return Fan	Snyder General	245 AF CW	AHU-6C-16 Return Fan	1992			Yes	7000 CFM	5 HP			
AHU-2E-17	AHU-2E-17	Const Volume Air Handler	MCQUAY	-	Air Handler for Staff Lounge Room 203.5	1992			-	-	-	Rm 203.5	7:00-23:00 M-F 7:00-23:00 S-S	Serves room 323
	2E-17 HWP	Heating Water Pump	B&G	-	AHU-2E-17 Heating Water Pump	1992			No	16.2 GPM	0.17 HP			
	S-2E-17	Supply Fan	MCQUAY	LSL 108	AHU-2E-17 Supply Fan	1992			No	3500 CFM	5 HP			
	R-2E-17	Return Fan	Bary Blower	TUB 182	AHU-2E-17 Return Fan	1992			No	3000 CFM	3 HP			
AHU-2E-18	AHU-2E-18	Const Volume Air Handler	MCQUAY	-	Air Handler for East Entrance & Vestibule	1992			-	-	-	Rm 203.5	7:00-23:00 M-F 5:00-23:00 S-S	
	2E-18 HWP	Heating Water Pump	B&G	Q78835	AHU-2E-18 Heating Water Pump	1992			No	23 GPM	0.25 HP			
	S-2E-18	Supply Fan	MCQUAY	LSL111	AHU-2E-18 Supply Fan	1992			No	5000 CFM	7.5 HP			
	R-2E-18	Return Fan	Bary Blower	TUB 222	AHU-2E-18 Return Fan	1992			No	4500 CFM	3 HP			
AHU-4A-19	AHU-4A-19	Dual Duct Air Handler	SEMCO	-	Air Handler for 4th Floor Classrooms	1992			-	-	-	Rm 403.1	24 hrs / 7 days	14 VAV boxes ranging in size from 520 to 1660 CFM
	S-4A-19	Supply Fan	Bary Blower	270 AF CCW	AHU-4A-19 Supply Fan	1992			No	15700 CFM	25 HP			
	R-4A-19	Return Fan	Snyder General	402 TUB AF CW	AHU-4A-19 Return Fan	1992			No	14200 CFM	10 HP			
AHU-4B-20	AHU-4B-20	Dual Duct Air Handler	SEMCO	-	Air Handler for 4th Floor Classrooms	1992			-	-	-	Rm 403.3	24 hrs / 7 days	10 VAV boxes ranging in size from 920 to 2040 CFM
	S-4B-20	Supply Fan	SEMCO	245 AF CW	AHU-4B-20 Supply Fan	1992			No	14300 CFM	30 HP			
	R-4B-20	Return Fan	Bary Blower	402 TUB AFC	AHU-4B-20 Return Fan	1992			No	12900 CFM	7.5 HP			
AHU-6B-21	AHU-6B-21	Dual Duct Air Handler	SEMCO	-	Air Handler for 4th Floor Research & Publications	1992			-	-	-	Rm 403.3	24 hrs / 7 days	7 VAV boxes ranging from 1010 to 2720 CFM
	S-6B-21	Supply Fan	Snyder General	245 AF CCW	AHU-6B-21 Supply Fan	1992			No	12400 CFM	25 HP			
	R-6B-21	Return Fan	Bary Blower	365 TUB AF CW	AHU-6B-21 Return Fan	1992			No	11100 CFM	7.5 HP			
AHU-4C-22	AHU-4C-22	Dual Duct Air Handler	SEMCO	-	Air Handler for 4th Floor	1992			-	-	-	Rm 403.5	24 hrs / 7 days	16 VAV boxes ranging in size from 260 to 2690 CFM
	S-4C-22	Supply Fan	Bary Blower	DWDI 330	AHU-4C-22 Supply Fan	1992			No	19300 CFM	40 HP			
	R-4C-22	Return Fan	Bary Blower	TUBULAR 445	AHU-4C-22 Return Fan	1992			No	17400 CFM	10 HP			
AHU-5A-23	AHU-5A-23	Multi Zone Air Handler	SEMCO	-	Air Handler for Gallery A	1992			-	-	-	Rm 503.1		4 Zones
	S-5A-23	Supply Fan	SEMCO	DWDI 365	AHU-5A-23 Supply Fan	1992			No	27000 CFM	50 HP			
	R-5A-23	Return Fan	Bary Blower	445 TUB AF CW	AHU-5A-23 Return Fan	1992			No	24300 CFM	15 HP			

System Tag	Equipment Tag	Equipment Type	Manufacturer	Model #	Discription	Year Installed	Year Upgr	Upgrade/Refirb Discription	VFD	Capacity	Motor HP	Location	Current Schedule	Notes
AHU-5B-24	AHU-5B-24	Multi Zone Air Handler	SEMCO	-	Air Handler for Northwest Gallery	1992			-	-	-	Rm 503.3	24 hrs / 7 days	6 Zones
	S-5B-24	Supply Fan	Bary Blower	402 AF CW	AHU-5B-24 Supply Fan	1992			No	33300 CFM	50 HP			
	R-5B-24	Return Fan	Bary Blower	445 TUB	AHU-5B-24 Return Fan	1992			No	30000 CFM	25 HP			
AHU-5C-25	AHU-5C-25	Multi Zone Air Handler	SEMCO	-	Air Handler for Gallery C	1992			-	-	-	Rm 503.5	24 hrs / 7 days	6 Zones
	S-5C-25	Supply Fan	Bary Blower	DWDI 402	AHU-5C-25 Supply Fan	1992			No	36000 CFM	60 HP			
	R-5C-25	Return Fan	Bary Blower	490 TUB	AHU-5C-25 Return Fan	1992			No	32400 CFM	25 HP			
AHU-6B-26	AHU-6B-26	Const Volume Air Handler	MCQUAY	-	Air Handler for North Spine Room 603.2	1992			-	-	-	Rm 603.2	7:00-23:00 M-F 5:00-23:00 S-S	Serves one space
	6B-26 HWP	Heating Water Pump	B&G	2 1/2 A09	AHU-6B-26 Heating Water Pump	1992			No	47 GPM	0.25 HP			
	S-6B-26	Supply Fan	MCQUAY	MSL117DH	AHU-6B-26 Supply Fan	1992			No	7500 CFM	10 HP			
	R-6B-26	Return Fan	Snyder General	270 TUB AF CW	AHU-6B-26 Return Fan	1992			No	6800 CFM	5 HP			
AHU-6B-27	AHU-6B-27	VAV Air Handler	SEMCO	-	Air Handler for Great Hall	1992			-	-	-	Rm 603.2	24 hrs / 7 days	50 VAV boxes ranging in cpaacity
	6B-27 HWP	Heating Water Pump	B&G	Inaccessible	AHU-6B-27 Heating Water Pump	1992			No	140 GPM	1.5 HP			from 300 to 2250 CFM
	S-6B-27	Supply Fan	SEMCO	490 AF CW	AHU-6B-27 Supply Fan	1992			Yes	58000 CFM	100 HP			
	R-6B-27	Return Fan	Bary Blower	DWDU 490	AHU-6B-27 Return Fan	1992			Yes	52000 CFM	30 HP			
AHU-7A-28	AHU-7A-28	VAV Air Handler	MCQUAY	-	Air Handler for 6th Floor Offices	1992			-	-	-	Penthouse A	6:55-17:00 M-F	28 VAV boxes ranging in capacity
	7A-28 HWP	Heating Water Pump	B&G	2 1/2 A09	AHU-7A-28 Heating Water Pump	1992			No	57 GPM	0.25 HP			from 150 to 1790 CFM
	S-7A-28	Supply Fan	MCQUAY	MSL164DH	AHU-7A-28 Supply Fan	1992			Yes	24800 CFM	40 HP			
	R-7A-28	Return Fan	Snyder General	TUB 490	AHU-7A-28 Return Fan	1992			Yes	22300 CFM	15 HP			
AHU-7B-29	AHU-7B-29	VAV Air Handler	MCQUAY	-	Air Handler for 6th Floor Offices	1992			-	-	-	Penthouse B	5:00-23:00 M-F 5:00-18:00 M-F	20 VAV boxes ranging in capacity
	7B-29 HWP	Heating Water Pump	B&G	Inaccessible	AHU-7B-29 Heating Water Pump	1992			No	41 GPM	0.25 HP			from 400 to 1300 CFM
	S-7B-29	Supply Fan	MCQUAY	MSL137DH	AHU-7B-29 Supply Fan	1992			Yes	17500 CFM	30 HP			
	R-7B-29	Return Fan	Bary Blower	445 TWB	AHU-7B-29 Return Fan	1992			Yes	15800 CFM	10 HP			
AHU-7B-30	AHU-7B-30	Const Volume Air Handler	MCQUAY	-	Air Handler for West Spline	1992			-	-	-	Penthouse B	24 hrs / 7 days	Serves one space
	7B-30 HWP	Heating Water Pump	B&G		AHU-7B-30 Heating Water Pump	1992			No	58 GPM	0.5 HP			
	S-7B-30	Supply Fan	MCQUAY	MSL128DH	AHU-7B-30 Supply Fan	1992			No	12900 CFM	20 HP			
	R-7B-30	Return Fan	Bary Blower	365 TUB AF CW	AHU-7B-30 Return Fan	1992			No	11600 CFM	7.5 HP			
AHU-2E-31	AHU-2E-31	Const Volume Air Handler	SEMCO	-	Air Handler for Chiller Room 203.5	1992			-	-	-	Rm 203.5	24 hrs / 7 days	Serves Chiller Room
	S-2E-31	Supply Fan	Bary Blower	330 TUB AF CM	AHU-2E-31 Supply Fan	1992			No	10000 CFM	7.5 HP			
AHU-5B-32	AHU-5B-32	Const Volume Air Handler	MCQUAY	-	Air Handler for AV Room	1992			-	-	-	Rm 503.3		
	S-5B-32	Supply Fan	MCQUAY	LSL108CV	AHU-5B-32 Supply Fan	1992			No	4000 CFM	5 HP			
-	Steam Generator #1	Steam Generator				1992			-		-	Rm 101.3		
-	Steam Generator #2	Steam Generator				1992			-		-	Rm 203.2		
-	Steam Generator #3	Steam Generator				1992			-		-	Rm 103.1		
-	Steam Generator #4	Steam Generator				1992			-		-	Rm 103.1		
-	Steam Generator #5	Steam Generator				1992			-		-	Rm 103.8		
-	FCU-1	Fan Coil Unit	MCQUAY	SCD-161	Fan Coil for Tunnel A	1992			No	440 MBH	2 @ 0.17 HP			
-	FCU-2	Fan Coil Unit	MCQUAY	SCD-121	Fan Coil for Tunnel C	1992			No	290 MBH	0.25 HP			
-	FCU-3	Fan Coil Unit	MCQUAY	SCD-061	Fan Coil for Room 103.8	1992			No	120 MBH	FR			
-	FCU-4	Fan Coil Unit	MCQUAY	SCD-121	Unit not active yet	1992	-	-	No	260 MBH	0.25 HP	-		Unit Not Active
-	FCU-5	Fan Coil Unit	MCQUAY	SCD-081	Fan Coil for Room 503.1	1992			No	190 MBH	0.17 HP			
-	FCU-6	Fan Coil Unit	MCQUAY	SCD-061	Fan Coil for Room 503.3	1992			No	120 MBH	FR			
-	E-5C-1	Exhaust Fan	Bary Blower	12A-RPK-BI-CW	Area D Toilet Exhaust	1992			No	980 CFM	0.25 HP		24 hrs / 7 days	
-	E-3C-2	Exhaust Fan	Snyder General	200 AF CW	Kitchen Exhaust	1992			No				Manual Switch	
-	E-3C-3	Exhaust Fan	Snyder General	200 AF CW	Kitchen Exhaust	1992			No				Manual Switch	
-	E-3C-4	Exhaust Fan			Kitchen Exhaust	1992			No				24 hrs / 7 days	
-	E-6B-5	Exhaust Fan	Bary Blower	18-RPK-BI-CW	Area D Toilet Exhaust	1992			No	2850 CFM	0.75 HP		24 hrs / 7 days	
-	E-6D-6	Exhaust Fan	Bary Blower	20-RPK-BI-CW	Area D Toilet Exhaust	1992			No	3790 CFM	1.5 HP		24 hrs / 7 days	
-	E-6D-7	Exhaust Fan	Bary Blower	9-AH-CCW	Fume Hood Exhaust	1992			No	1200 CFM	1.5 HP			
-	E-6D-8	Exhaust Fan	Bary Blower	9-AH-CW	Fume Hood Exhaust	1992			No	940 CFM	1.0 HP			
-	E-6D-9	Exhaust Fan	Bary Blower	9-AH-CW	Fume Hood Exhaust	1992			No	1200 CFM	1.5 HP			
-	E-6D-10	Exhaust Fan	Bary Blower	17-AH-CW	Lab 108.1 Sink Exhaust	1992			No	3600 CFM	1.5 HP			
-	E-6D-11	Exhaust Fan	Bary Blower	9-AH-CCW	Lab 109.1 Fume Hood Exhaust	1992			No	1200 CFM	1.5 HP			
-	E-6D-12	Exhaust Fan	Bary Blower	9-AH-CW	Lab 109.1 Fume Hood Exhaust	1992			No	1200 CFM	1.5 HP			
-	E-6D-13	Exhaust Fan	Bary Blower	19-AH-CCW	Conservations Labs Extractor Arms Exhaust	1992			Yes	6000 CFM	7.5 HP			
-	E-3C-15	Exhaust Fan	Bary Blower	10 RPK-BI-CW	Level 3 Area C Exhaust	1992			No	460 CFM	0.25 HP		24 hrs / 7 days	
-	E-6D-16	Exhaust Fan	Bary Blower		Lab 150 Fume Hood Exhaust	1992			No	1000 CFM	0.75 HP			
-	E-2A-17	Exhaust Fan	Bary Blower	24RPK-BI-CW	Photo lab Exhaust	1992			No	5500 CFM	5.0 HP			
-	E-1E-18	Exhaust Fan	Bary Blower	10-RPK-BI-CW	Mold Treatment Rm167	1992			No	340 CFM	0.25 HP			

System Tag	Equipment Tag	Equipment Type	Manufacturer	Model #	Discription	Year Installed	Year Upgr	Upgrade/Refirb Discription	VFD	Capacity	Motor HP	Location	Current Schedule	Notes
-	E-1E-19	Exhaust Fan	Bary Blower	10-RPK-BI-CW	Air Abraisive Unit in Machine Rm154	1992			No	320 CFM	0.25 HP			
-	E-1E-20	Exhaust Fan	Bary Blower	10-RPK-BI-CW	Pest Control Rm166	1992			No	960 CFM	0.25 HP			
-	E-1C-21	Exhaust Fan	Snyder General	12 RPK BI CW	Photo Roomo 118 Exhaust Paint Booth	1992			No	1500 CFM	0.75 HP			
-	E-1E-22	Exhaust Fan	Bary Blower	10-RPK-BI-CW	Storeroom 165 Exhaust	1992			No	220 CFM	0.25 HP			
-	E-1C-23	Exhaust Fan	Bary Blower		Lab 108.1 Sink Xfer Fan	1992			No	470 CFM	0.25 HP			Status only, no BMS control
-	E-1E-24	Exhaust Fan	Bary Blower	10A RPK-BI-CW	Holding Room 164 Exhaust	1992			No	740 CFM	0.25 HP			
-	E-1E-25	Exhaust Fan	Bary Blower	12-RPK-BI-CW	Level 1 Area C Toilet Exhaust	1992			No	1000 CFM	0.25 HP		24 hrs / 7 days	
-	E-7B-26	Exhaust Fan	Bary Blower	10 RPK-BI-CW	Design Room 647 Exhaust	1992			No	600 CFM	0.25 HP		24 hrs / 7 days	
-	E-OA-27	Exhaust Fan	Bary Blower	182-TUB	Utility Tunnel Exhaust	1992			No	5000 CFM	3.0 HP			
-	E-OA-28	Exhaust Fan	Bary Blower	182-TUB-AF-CW	Utility Tunnel Exhaust	1992			No	5000 CFM	3.0 HP			